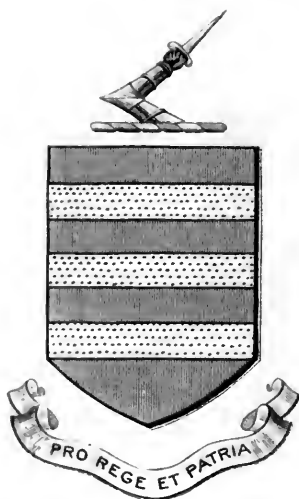


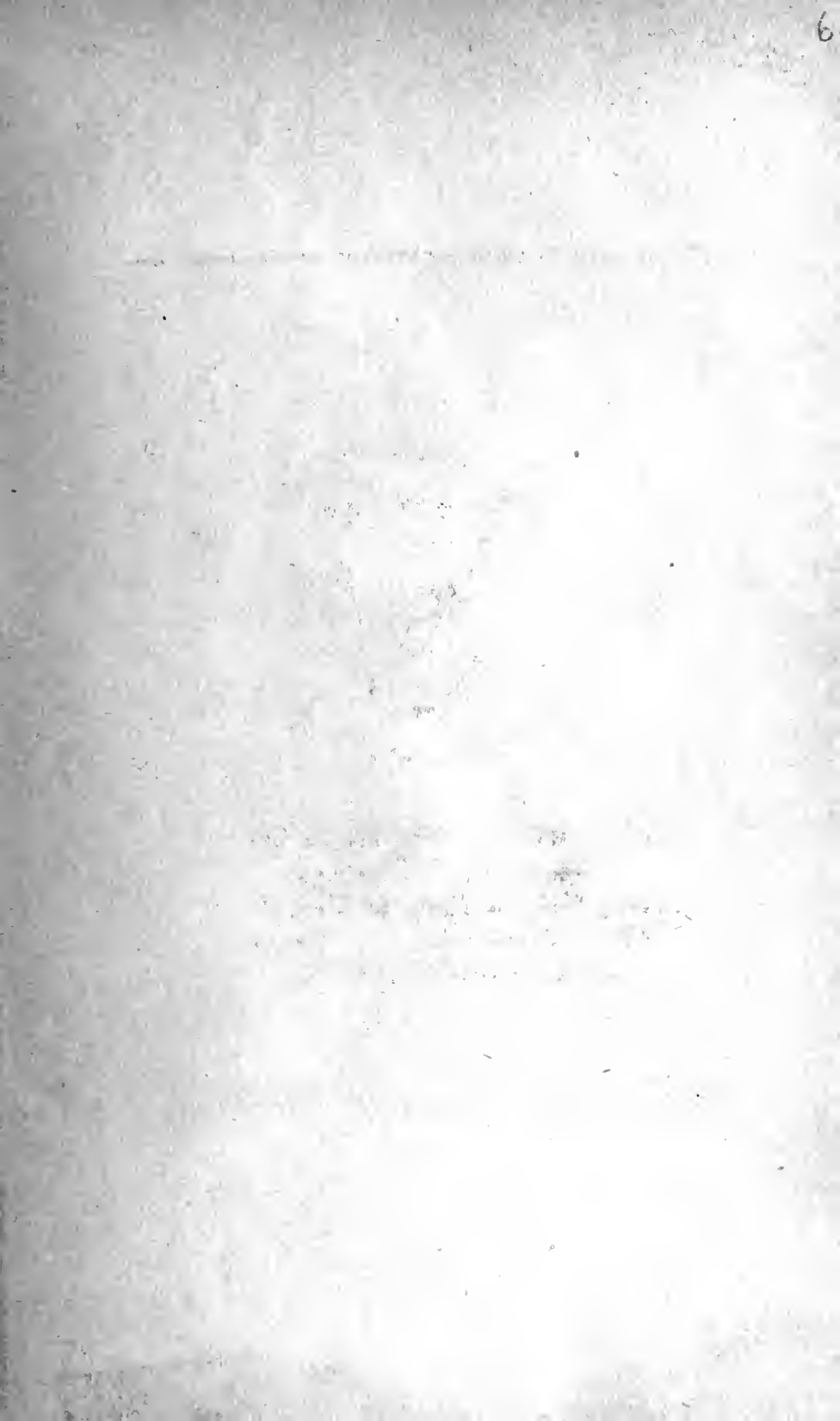
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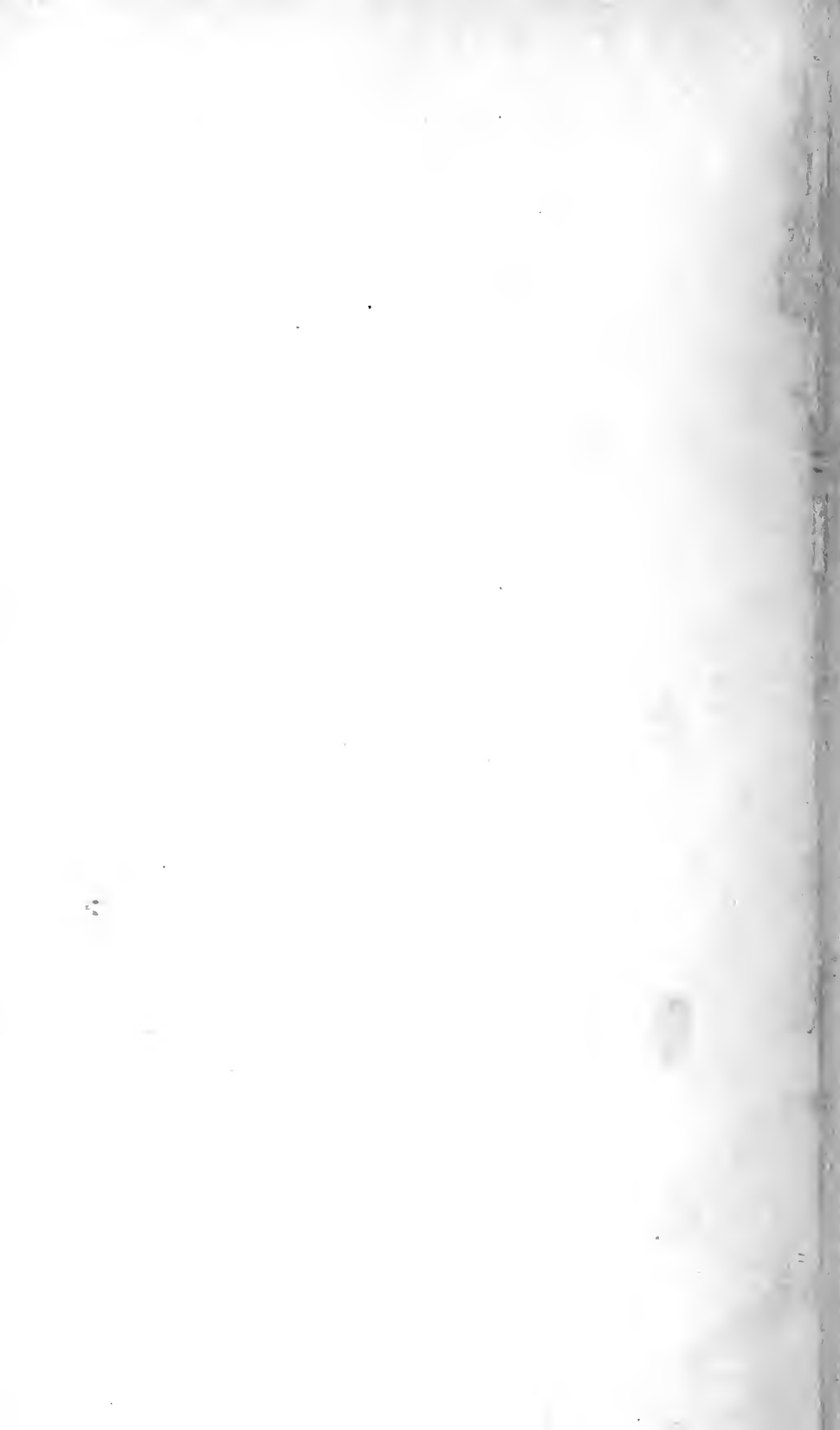
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# DISEASES OF THE BONES AND JOINTS

CLINICAL STUDIES

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TO THOSE WHOSE  
PATIENT SUFFERING  
UNDER THE BURDEN OF  
DEFORMITY, DISABILITY AND DISEASE  
HAS  
FURNISHED THE INCENTIVE  
FOR INVESTIGATION,  
THIS BOOK IS  
DEDICATED





## PREFACE

IN presenting the following Studies a word of explanation of their scope seems necessary. Important as is a profound knowledge of the tissue changes which underlie outward manifestations of disease, it is rarely the case that such knowledge furnishes an incentive for unraveling the mystery of complex clinical problems. This is true of acute conditions and must in the very nature of things be all the more true when chronic affections are concerned. Painstaking bedside observations are of more real value, taken by themselves, than the most minute pathological researches. One of the chief difficulties which has opposed itself to the understanding of chronic joint problems has been the paucity of clinical, and the fragmentary character of pathological, data. Sufferers from these conditions rarely afford one the opportunity to study their lesions at a time when they are pathologically significant. If one must await his chance of procuring such evidence, his patients may readily pass out of the period when treatment is of much avail. It is to those practitioners of medicine, therefore, to whom sufferers from joint disease usually make their first appeal that these Studies are offered. To them a treatise on diseases of the bones and joints which is wholly comprehensive would be too ponderous. It has seemed best to include only those diseases which are most common, and to endeavor to give a concise statement of such matters pertaining to etiology, diagnosis, and treatment as has been found in the authors' hands to be helpful and satisfying to the patient and suggestive to the physician. For this reason no attempt has been made to write an Orthopædic Surgery, the scope of which would necessarily have been much broader. In the consideration of individual topics the writers have endeavored to present some one fundamental principle, whether it concern etiology or treatment, rather than to offer a large number of suggestions, many of which have had no adequate trial. The space devoted to the pathology, particularly of the non-tuber-

culous arthritides, is meagre for the reason that the amount of exact knowledge on this subject is extremely slight. Discussions of the pathology of these conditions based upon studies of post-mortems performed late in the disease are obviously not representative of the essential changes. In the matter of the use of apparatus for the treatment of joint disease, the writers have chosen to emphasize the principles underlying its use and describe in detail only that particular form of apparatus which they themselves have found most satisfactory for the majority of patients. Individual cases will require special modifications, but the authors have sought to lay stress on the principle and not its exceptions. Certain of the rarer forms of bone disease are treated briefly, largely to aid the general practitioner in his diagnosis of obscure cases.

The subjects treated in this book comprise a large number of those conditions which for many years have been neglected. Chronic disease has its problems no less than those presented by acute processes, and our profession has been slow to awaken to the importance of these matters.

Regarded from any view-point sufferers from these conditions make claims upon our consideration. Their bodily sufferings demand relief, if relief may be had; the incapacitation of an adult wage-earner results in economic loss to himself, to his dependents, and perhaps to the State, and also entails an element of mental distress which must be added to his physical suffering. A certain amount of permanent disability is likely to result in these cases even under the most favorable conditions of recovery, and these facts bring into the subject elements that do not need to be considered in most cases of acute illness. Certainly such considerations if there were no others should suffice to promote research into the causes of pathological processes competent to produce such results. Ordinary humanitarian impulses should prompt us to attempt their relief, and last of all, though by no means least of all, should we be appealed to by a sense of the importance of the solution of these problems to the State and the future of the race.

The very nature of these processes renders them abhorrent to the busy general practitioner and the surgeon. Their lesions are apparently not even interesting to the average consulting internist. There is no one therefore to whom these unfortunates may turn except to a comparatively small group of medical men who by their training are fitting themselves to grapple with just such problems. There is a wide field and a great opportunity for those who are disposed to undertake this work, and out of it must necessarily come much that will benefit the whole field of medicine. More than in almost any other branch of medical science will coöperation and patient research along all lines help us in arriving at the goal. The general practitioner must bear his share in unraveling the mystery of many of these problems, as well as the heavy end of the load where treatment is concerned. The present time offers unusual opportunities to those who are fully awake to the importance of these questions. The writers feel that complex as many of the problems are, they are as capable of solution as many other problems now solved. If those of us who have the opportunity will persevere in patience, we shall realize that no reward can be greater than that of having contributed to the relief of this large class of humanity, which until recently has been so largely ignored.



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### CORRIGENDA

Page 148. Description of Figure 75 should read: "Illustrates early disease" instead of "Illustrates an early erosion of the femoral condyles."

Page 154. Description of Figure 79 should read: "Illustrates the squaring of the tibial epiphysis" instead of "Illustrates the squaring of the femoral epiphysis."

Page 307. Description of Figure 148 should read: "This being due to atrophy of all the joint structures" instead of "This being due to an atrophy of the cartilage between the bones."

Page 494. Description of Figure 219 should read: "The opacity is much diminished" instead of "The radiability is much diminished."



DISEASES OF  
THE BONES AND JOINTS



# Diseases of the Bones and Joints

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## SECTION I

### TUBERCULOSIS OF BONES AND JOINTS

#### INTRODUCTION

THE writers in their consideration of the subject of bone and joint tuberculosis wish to lay especial stress upon the fact that the constitutional disturbances which are produced by tuberculous lesions in the lung or other soft parts may be also produced by tuberculous lesions in the osseous skeleton or its articulations. It is their belief also that to this resulting general constitutional debility all the more serious features of joint tuberculosis, except of course deformity and its attendant disabilities, may be attributed. If these beliefs are well founded it should follow that the chief end of treatment should be to counteract constitutional invasion in those subject to tuberculous infection. That this has not been the feature of treatment receiving most emphasis one has only to peruse the text-books of orthopædic surgery to appreciate. By far the greatest stress is laid upon the mechanical treatment of local lesions.

In whatever tissues of the body one studies the changes produced by the tubercle bacillus the histological picture is practically always the same. Differences in structure of these tissues may render one region of the body a little less or a little more resistant to invasion than another, but the virulence of the invading organism and the relative constitutional immunity of the patient are of more importance in this connection than the character of tissues invaded.

**Etiology.** Tuberculous bone lesions are due to the presence of the tubercle bacillus, acting both locally and constitutionally. It is usually possible to demonstrate the presence of the organisms if the

tissue can be subjected to examination. If the tissues themselves cannot be examined, bacilli may be found in 50% of the cases, in pus aspirated from the affected region. Just how an individual joint becomes involved is not always clear, but it is probable that through the tonsils and the respiratory and alimentary tracts organisms gain entrance to the body, are sifted through the lymphatic glands, and eventually carried by the blood stream until they are destroyed or find lodgement favorable for their growth. The fate of such invading organisms depends on the one hand upon the development of the patient's general resistance to tuberculous infection, and on the other upon the presence of factors recognized as exciting causes for the focalization of tuberculous lesions, as for example a trauma, which lowers the local resistance of tissues and makes of them favorable culture media for tubercle bacilli. It is also probable that the development of local tuberculous lesions is influenced by a loss in the power of resistance of the tissues, induced by injuries or inflammatory conditions which of themselves would be considered trivial. The frequent association of tuberculous lesions with such states of debility as follow measles, scarlet fever, typhoid and influenza, etc., indicates that the tubercle bacillus finds such conditions favorable for invasion. The popular belief that injury provokes the development of tuberculous foci is well grounded in fact. The traumatism however stands in the relation of an exciting cause, just as the lowered constitutional conditions above cited stand as contributory factors.

As a result of recent investigations it can be shown that organisms can pass through certain of the tissues, especially the tonsils and the mucous membrane of the gut, without causing any appreciable sign of infection in those tissues. Hereditary influences play an inconspicuous part in the etiology of osseous tuberculosis. Occasionally one finds a striking example of the dissemination of tuberculous osseous lesions through a family, but the number of tuberculous lesions in bone is so small compared with that of pulmonary lesions that in questioning patients for precedent tuberculosis it is quite rare that other members of the family are found with joint disease,

whereas a history of pulmonary disease in the family is very common. It does not ordinarily enter our calculation when advising against the dangers of contagion in pulmonary tuberculosis that other forms of the disease than the pulmonary may be derived from such contagion. Such is doubtless the case as has been recently shown by the investigations of Wallace.<sup>1</sup> The writers have seen one family in which there were five children the two older of whom, one a boy and the other a girl, had together six tuberculous lesions. Both had quiescent pulmonary lesions and bone lesions in two joints. The boy had tuberculosis of the knee requiring excision, and tuberculosis of the terminal phalangeal articulation of one great toe requiring amputation. The girl had tuberculosis of the hip with shortening and ankylosis, and tuberculosis of the greater tuberosity of the right shoulder, for which a partial resection of the shoulder joint was performed. Of the younger children, one had tuberculous cervical adenitis and one tuberculous peritonitis. The fifth was apparently healthy. The genealogical tree of this family, showing their tuberculous taint, was reported some years ago in the "Boston Medical and Surgical Journal."<sup>2</sup>

The importance of contagion was very suggestively brought out by Squires in a study made some years ago at one of the large London hospitals. This writer showed that in families where the father was phthisical but able to keep at his work, and the children were young, contagion did not occur as frequently as it did in families where the mother was phthisical and stayed at home, though about her household duties. When the phthisis developed in either parent where the children happened to be older and were consequently away at school or at work the greater part of the day, there was less contagion than where they were more constantly brought in contact with a tuberculous focus. Such observations speak very strongly for the contagious nature of tuberculosis, a fact which needs no demonstration in these days at least when the subject under discussion is the pulmonary form. In the propaganda against tubercu-

<sup>1</sup> *American Journal of Orthopædic Surgery*, January, 1908.

<sup>2</sup> *Boston Medical and Surgical Journal*, April 24, 1902.

losis however we should not overlook the fact that the obliteration of this dread disease will result in wiping out those forms of tuberculous disease known to the lay public as "Hip Disease," "Hump-back," "White Swelling," and all other types of tuberculous infection.

Much investigation has been carried on with reference to the question of the identity of the human and bovine forms of tuberculosis and the communicability of one form to an individual member of the other species. Koch and Behring in Europe and Theobald Smith in this country have studied the matter most thoroughly. There are great difficulties in the way of differentiation of types and long periods of time are required to positively establish the difference. Commissions appointed in Germany and England to study the question found considerable evidence to prove that the bovine type was associated with those tuberculous lesions which are most frequently met with in children and were not as often demonstrable in adult forms of tuberculosis. These facts would lend support to the efforts of those local and national organizations which are endeavoring to protect the people from tuberculous cattle. The importance of this matter cannot at present be positively stated inasmuch as some of the foremost authorities are still in disagreement.

**Distribution and multiplicity of lesions.** The writers' experience is in accord with the reported statistics. The spine, the hip, the knee, the ankle, the elbow, the wrist, and the shoulder represent the order of frequency in which these lesions occur. In general it will be seen, when these statistics are carefully digested, that the joints most exposed to trauma, either in the nature of direct violence or in the course of ordinary use, are the joints showing the greatest tendency to harbor tuberculous infection. Tuberculous bone and joint lesions are usually monarticular, though multiple foci are not unusual. Where this multiplicity of involvement concerns both hips or both knees or two separate foci in the vertebral column, or a hip and a knee, or a knee and an ankle, diagnosis is comparatively easy. When however destruction does not take place in any of the localities where the disease manifests itself the case becomes

more difficult. Under such circumstances the deformities which usually characterize tuberculous arthritis are not in evidence and an important aid in diagnosis is on that account lost. In some cases as many as six separate, superficial foci have been seen occurring in bone and not involving an epiphysis, constituting a multiple tuberculous osteomyelitis.

As a rule in multiple tuberculous joint lesions the involvement of the individual joints is not as severe as when the entire force of an infection is expended upon one articulation. In our experience a large number of cases have been observed in which there were at least two osseous foci. In the great majority of such instances the destructive changes in the individual joints have not been as severe as they usually are in cases of monarticular involvement. The second of the two commonly runs the milder course. The probable explanation of this phenomenon will be discussed later when considering the production of opsonins as a measure of protection. We cite the following case as typical of many.

Mrs. F. B., age 33, was first seen in the Fall of 1905. At that time she complained of pain in the lower part of her back, the right side, and right thigh; this was very severe at night and it was impossible to rest in one position for any length of time. Motion of the spine, such as was involved in turning over in bed or rising to the sitting posture, was very painful. When walking about she was quite comfortable. These spinal symptoms came on during the convalescence from her first confinement, which occurred four months before she first sought advice for her spinal trouble. When she was a young girl she was thought to have pulmonary tuberculosis, and was treated for some time for such a condition, but had entirely recovered. Four years before her baby was born she had what was diagnosed as pneumonia, during the convalescence from which both her ankles, her right great toe (second phalangeal articulation), and her knees were swollen and inflamed and gave her a good deal of trouble; in fact the right ankle and toe have never ceased to cause her trouble and have always been more or less swollen. Upon examination the patient was found to be rather poorly nourished and in poor general condition. She walked without limp. In standing there was an extreme lordosis, and spinal motions were restricted in lateral bending particularly, though

flexion was guarded. Muscle spasm was brought out by any attempt at motion. Abdominal examination was negative except for some tenderness on deep palpation over the right hypochondrium. The right ankle was swollen below the malleoli and the fossæ behind these prominences were filled up. Ankle joint motions were not restricted except in dorsi-flexion. Over the outer, anterior aspect of the dorsum of the foot on a level with the line of the articulation between the tibia and the astragalus was a small, fairly moveable body the size of a filbert, which was tender to pressure but did not appear to be within the joint. An X-ray of the spine showed a small, eroded spot on the side of one of the lumbar vertebræ; X-ray of the ankle showed a soft-part lesion in the place above described. There has also been a destruction of the end of the second phalanx of the right great toe and an absorption of its cartilage. About a year after her first examination the ankle became so acutely inflamed that operation was advised, and a mass of tuberculous material, which seemed to be wholly confined to the soft parts, was removed from the front of the right ankle joint. In spite of these three separate lesions, two of which have given rise to rather severe subjective symptoms, the patient is recovering with very slight disability and practically no deformity. The character of these lesions has been proven to be tuberculous in the case of the ankle by histological examination. A large psoas abscess developed at one time in the right groin, and this, together with the erosion of the vertebræ demonstrated in the X-ray, points very strongly to the tuberculous character of the spinal lesions. The tissue which was removed from the ankle and subjected to histological examination was as actively tuberculous as is ever seen if one can judge at all of the activity of such a process from the number of tubercles and giant cells. Some factor seems to have been present in this case rendering the bacilli relatively innocuous.

**Clinical course.** Tuberculous lesions in bone occur most frequently at a period before complete ossification has taken place, but it must be borne in mind that there is no age at which there is exemption from this disease. It is not alone the difference in density of bone prior to union of the epiphyses with the diaphyses which determines the greater prevalence of tuberculous lesions during this period. In all probability an increased density of bone would limit the extension of tuberculous lesions and confine them to narrower boundaries, but the explanation of such phenomena as that recited



in the case above referred to and in numerous similar cases which might be reported must be sought in an understanding of constitutional resistance. Most clinical phenomena connected with tuberculous lesions seem to indicate some such explanation. Local extension, multiple, possibly metastatic foci and disseminated miliary infection as well as the primary focus, all seem dependent for their very existence upon some depression of constitutional resistance to tuberculous infection. Local walling-off and consequent isolation of a tuberculous focus, whether it be in soft parts or bone, is invariably associated with, and presumably is in consequence of, an augmentation of the resistive powers of the individual to such infection.

There is every reason to suppose that there are variations in the virulence of tuberculous organisms and that for the same strain of bacteria there may be different degrees of virulence from time to time or from generation to generation. Environment, food supply, and other circumstances doubtless influence bacterial life as they do the life of individuals of other species. The influence for good or bad of succeeding generations of tubercle bacilli doubtless is in many cases expressed in terms of human suffering and deformity. Certainly the progress of a tuberculous infection in a human being is often marked by many fluctuations. When tuberculous infections are regarded in this light, prognosis resolves itself into attempts to determine the probable individual resistance of the patient and not merely into a guess as to how long it will be necessary to wear apparatus, based upon the experience of others in treating the local evidences of tuberculous disease at the expense of treatment of the disease itself. Variations in the severity of infections for which there seems no rational explanation, and reasons for the adequacy or inadequacy of treatment will not then seem so obscure. Treatment itself may then be less harrowing to the patient and occupy a shorter time because many of the local signs to which so much importance has attached will not be regarded as essential in determining the continuance or omission of local treatments.

The present theory of immunization by means of opsonins offers

a very real hope that through them the nature of the disease may be modified, and that even the more virulent forms may be controlled. The method is of course too new to permit any positive opinion regarding it, but apparently the progress of tuberculous lesions has a definite relation to the phagocytic power of the leucocytes, and if this power can be increased the virulence of the disease, whether local or general, may be lessened.

In facing the problem of tuberculosis in the bones and joints, it should be clearly borne in mind that because a patient has this disease he is not necessarily doomed, and there is no reason for the panic so often seen among the medical profession and the patients. The disease is serious, but infection of a bone or joint or some vital organ with tuberculosis does not necessarily mean that that portion of the body must be extirpated. In treating it we are dealing with an infectious process which in many instances may produce destructive changes with much mutilation and with frequent extension to other organs, but which in other instances, even under unfavorable conditions, and still more often under favorable conditions, ceases, with little impairment in function of the affected part.

It is our duty to recognize these two extremes and decide in each case upon the plan of treatment appropriate to the case. If the patient is in good general health, with no loss of weight, no elevation of temperature, or other symptoms indicating that the tubercle bacilli have not been kept under control by the natural resistance of the individual, there certainly is no reason to feel that the area of disease must be at once removed. Naturally, these organisms are not desired and it is right to exercise every reasonable precaution against their introduction, but while under certain circumstances they may cause great disaster, we realize that under ordinary conditions Nature, if she have a fair chance, is amply able to protect the individual against their attack.

Considerable discussion has arisen in recent years regarding the aspects of tuberculosis as a social disease. The trend of the discussion has led especially into the field of pulmonary tuberculosis because of the greater possibility of its extension by direct contam-

ination or infection, and as one pulmonary case may be usually traced to another, there is every reason to suppose that in the same family it is possible to have a bone focus in one individual derived from a pulmonary focus in another member of his or her family, as has been before stated. At the risk of repetition it seems to us important to emphasize the fact that those measures which are designed to stamp out pulmonary tuberculosis from the community must have a decided influence in lessening the frequency of the osseous type of this disease. That this is not merely of secondary importance may be readily appreciated when one considers the great frequency of tuberculosis among the total number of diseases which come to the general surgeon and the specialist in gynæcology, urology and orthopædics. Such lesions are not attended with a high mortality as so large a proportion of the pulmonary cases formerly were, but by them the total efficiency of the human family is very materially diminished, not to mention the effect which individual invalidism may have upon the future health of direct descendants and in the aggregate upon the development of the race.

**Pathology.** A knowledge of the surgical pathology of bone and joint tuberculosis is essential in determining treatment. A central area of necrosis and caseation marks the point of attack. Here the specific toxins are produced, the effect of which is to destroy adjacent cells. By the fusion of many tubercles many cells may be destroyed, and if this is rapid so that there is destruction of a considerable portion of bone at one time the formation of sequestra may result. In childhood, where the disease develops in partially ossified bone, it extends along the soft hyaline or epiphyseal cartilage more rapidly than in the bone itself, and the ossified area is occasionally entirely surrounded and destroyed. This is shown in Figure 1, in which case at the time of operation the whole ossified portion of the growing centre of the astragalus was loose and could be shelled out, leaving a cavity in the hyaline cartilage lined with miliary tubercles.

Coincident with the destruction of cells disintegration at once begins. In such foci of disintegration, whether in bone or elsewhere,

the disease is constantly developing at the periphery, the abscess representing the softened centre of the diseased area; the periphery, or wall of the abscess, is made up of individual tubercles fused

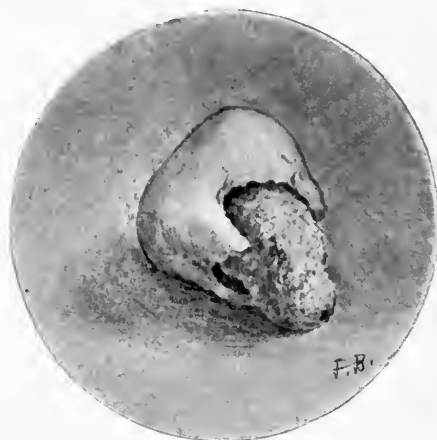


FIG. 1. The illustration was made from a specimen of an astragalus which was tuberculous. Observe the sequestration of the central portion which is protruding from the cortical shell.

together, suggesting in appearance a membrane, originally described as the pyogenic membrane.

The epiphyseal origin of bone tuberculosis as opposed to its primacy in the shafts of long bones represents the commonest condition. Occasionally tuberculosis may give rise to pathological appearances which are indistinguishable grossly from the bone lesions commonly associated with an osteomyelitis. The following case is sufficiently convincing on this point to merit quotation in some detail.

P. C., a boy, æt. 9 years, entered the Surgical Out-Patient Department of the Hospital in August, 1905, complaining of pain in the right hip which began suddenly, without any traumatism and without previous similar attacks, only two days before coming to the Clinic. Except for this subjective complaint there was nothing to be learned or observed. At the next visit two days later he walked a little lame and there was slight restriction of motion in outward rotation of the right thigh. He had a temperature of  $102^{\circ}$ . His pain had become worse but there were no other physical signs.

He was admitted to the Hospital the following day and operated upon, as his temperature had risen to  $103^{\circ}$  and he showed signs of being quite toxic. At operation a necrotic cavity was exposed in the neck of the femur and a small amount of thin pus was evacuated. The dead bone was removed and the wound drained. The temperature came down promptly and the wound closed quickly. Three weeks later however acute signs appeared below the trochanter, the temperature went up again, and a second X-ray showed extension of the process along the shaft of the femur as well as up toward its head. A second and very radical operation was performed and the greater part of the head and neck was removed with some portions of the shaft. For a time the child's condition was improved but he developed an acute nephritis about six weeks after this operation. This became a chronic condition and the urine contained all varieties of casts and a large percentage of albumin. Sinuses were discharging in three or four places about the buttock; the liver and spleen were much enlarged, and the conditions present showed all the signs of amyloid disease. Cultures from the pus of the first operation were negative. Some of this was injected into a guinea pig and a typical tuberculous lesion developed in six weeks. Histological examination of the tissue removed at this time showed tubercles in the bone marrow. An acute onset with rapid development of suppuration, high temperature, pain, emaciation, amyloid changes in kidney and liver, presented a clinical picture suggestive of an acute osteomyelitis merging into a chronic condition. Histologically and bacteriologically the case proved to be tuberculosis.

Coincident with the destructive process repair commences. Epithelioid cells gather about the caseating centres; some of their nuclei go to make up the giant cells which are so characteristic of the presence of tuberculosis, but not absolutely essential to its diagnosis. Around this is a zone of round cells, and an occasional leucocyte may be present. The fusion of many of these makes a conglomerate tubercle which may caseate, forming the nucleus of a cold abscess.

Such foci are usually in the epiphyses, and if centrally located they may work toward the cartilage covering the joint and gain access to the articulation in that way, or they may, though much less frequently, proceed toward the diaphysis and come to the surface well away from the joint. In the knee, for instance, the joint

most often and best seen at operation, the favorite seats of the disease are in the epiphyses of the femoral condyles, or in the head of the tibia. From the femoral epiphyses the bacilli find their way to the joint surface through the intercondylar notch, or more peripherally along the edges of the trochlear surfaces. The destruction of cartilage takes place from within outwards as a rule, and frequently the entire cartilage covering a condyle may be lifted off *en masse*. At other times a reddish, vascular granulating pannus may overlie the margin of the cartilage, showing an eroded surface underneath when the pannus is pushed aside. The entire synovial membrane may be infected from this source, showing a purplish, infiltrated, and mildly villous hypertrophy of the entire membrane. It is occasionally much thickened and is usually adherent in various places to some portion of the adjacent membrane apposed to it. There is commonly some slight excess of fluid and this contains caseating detritus in greater or lesser amounts. In considering the appearance of the joint it must be remembered that the disease is frequently primary in the bones, yet at the same time it not infrequently seems to start as a synovial process, the bone being affected secondarily. This cannot be proven pathologically, but there is abundant clinical evidence, most significant of which is the fact that tuberculous lesions have been found in every other serous cavity of the body dissociated from osseous foci, and there would seem to be no reason for exempting the synovial membranes of joints. The evidence usually cited as proof of the universality of osseous origin is derived from operative or post-mortem material. Operative material does not represent a stage of the disease when such conclusions are justifiable, for surgeons rarely have the opportunity of operating upon the synovial cases in their incipiency. Moreover skiagraphs offer interesting if not conclusive evidence that the disease often primarily affects the soft parts.

It is very common to find in the early stages of a lesion later proved to be tubercular an increased density of the soft parts enclosing the articular surfaces. We take this to mean either increase in the joint fluid or thickening of the synovia or both. In

such a case, although bone structure be well shown, no focus of disease can be demonstrated and often never appears if the disease progress favorably.

If on the other hand the case goes on to bone destruction, the erosion is seen first on the articular surface and thence invades the epiphyses from without inward, while at no stage is there evidence of an internal bone focus enlarging and extending from within outward.

The acute lesions which have just been described are easily recognized. Difficulty arises in determining the limits of the process and also what indicates repair, both in the diseased bone and in the soft parts, where a protective fibro-synovial pannus is Nature's most common method of preventing extension. On opening large joints the cartilage may seem intact, but will often be found to cover a cavity or cavities in the bone beneath. These cavities may contain slumbering disease; repeatedly the writers have seen such cavities in an active eruptive stage with granulation tissue growing up out of them and infecting the synovia in the immediate neighborhood. On opening such a joint the general cavity of the articulation may appear normal except that the synovial membrane is slightly thicker than usual but without villous change. A reduplication of the joint membrane will be found folding itself over a cavity such as has just been described, and when this is incised it may be possible to demonstrate fulminating disease within. There may be very little restriction in the motion of such a joint, and it is in this kind of an articulation that conservative surgery finds its most favorable opportunity. In it there is a considerable portion of the articular surface which is intact; there is a protective cordon of fibrous tissue shutting off a slumbering focus from the healthy tissue of the joint, and local extirpation, if thoroughly done, should be able to eradicate the disease and preserve existing motion.

The pathologically hopeless joint in the adult is the one in which there is a considerable amount of flocculent exudate with thickened, vascular, synovial membrane, eroded cartilage, and a destroying pannus creeping up over the borders of the trochlear surfaces. If

the process is arrested, as it may be even after extensive destruction has occurred, the eroded bone is never replaced by new-formed bone, but the necrotic area is filled in by fibrous tissue alone, or by a combination of calcified detritus from a cold abscess and fibrous tissue.

The permanency of repair of damage caused by tuberculous disease is dependent upon the completeness of the fibrous infiltration of the focus and the obliteration of the cavities produced by the disease. It is in these cavities that organisms are found and always possess the potential of recrudescence. It is for this reason that central lesions, that is, those which are situated in the body of the epiphyses and which do not open widely into the articulation, are more dangerous than the erosions which extend into the epiphysis from the joint side and thus have as a rule a wider portal for discharge. The practical bearing of the knowledge of the methods of repair is of great value from the viewpoint of surgical pathology. It affords in the first place, a probable explanation of the capacity of childhood and youth to combat tuberculous lesions so successfully, inasmuch as the rapidly growing tissues of early life have a great propensity for the manufacture of fibrous tissue. It enables us, in the second place, to decide upon the proper time to interfere in cases suitable for operation in the adult, where radical measures in the treatment of surgical tuberculosis have so much wider application. The chances of dissemination of tuberculous disease by such procedures must be reckoned with, but such risks as there are will most certainly be greatly diminished if we allow enough time for the establishment of fibrosis about a tuberculous focus. Where this has not taken place and surgery is undertaken, bone surfaces are laid bare and infective material may be thrown directly into the local circulation, and from thence a general miliary process may be precipitated upon the individual.

The presence of active disease, whether primary or relapsed, can be positively diagnosed when other signs fail or are not sufficiently convincing, by the application of a test derived from physiological chemistry. It seems proper to refer to this test in this place because



its basis is closely related to the principles underlying the newer treatment of tuberculous lesions and such treatment is based upon newly acquired knowledge, not of pathology but of chemistry.

The "new tuberculin" of Koch (T. R.) or the tuberculin prepared by Trudeau at Saranac has been found to be reliable for use in this work. The most important feature of this reagent for diagnosis is its local reaction, a constitutional disturbance being of very uncertain diagnostic value. It is of course likely that very many persons have about them in the glands or elsewhere foci of tuberculous disease that are capable of reacting upon inoculation with tuberculin, so that malaise, elevation of temperature, vomiting, and other constitutional symptoms which are indicative of the constitutional reaction to tuberculin are not the signs upon which reliance should be placed in determining the existence of local tuberculous foci in joints.

If an articulation is affected with tuberculous disease and the minimal dose of tuberculin is inoculated into the patient subcutaneously, acute symptoms will develop in the affected joint. If the joint disease is not tuberculous no local reaction will take place. This has been so often observed and failure to react in this way is of such infrequent occurrence that it is safe to regard it as one of the most reliable tests which we have at our disposal for discriminating between tuberculous and non-tuberculous conditions. The local reaction consists in swelling, tenderness, sometimes redness, muscular spasm, and all the signs which are characteristic of an active process. This however is only a transient reaction. It does not remain as a permanent condition and speedily quiets down, in fact is usually entirely over within forty-eight hours. It is best to inject from one to three or in some cases five milligrams of Koch's new tuberculin in the back between the shoulder blades, in the thigh, or in the loin. If this is done aseptically there should be no reaction at the seat of the inoculation. In about eighteen hours the temperature rises to its maximum; the constitutional reaction reaches its height, and a local reaction should be looked for. In from twelve to twenty-four hours after this the temperature should return

to normal, and local acute symptoms if brought out by the inoculation should disappear. In those cases where a reaction has occurred, and where it has been possible to confirm this observation by operative procedures, there have been no failures to demonstrate the presence of tuberculosis.

If the minimal dose of one milligram fails to produce a local reaction it is advisable before positively excluding tuberculosis to increase that doseage to three and subsequently to five milligrams, made some three or four days after the reaction should have occurred. Complete reliance should not be placed on this or any other single test. Accidentally conditions may intervene which may confuse either by producing no reaction or by changing its usual character, but if taken in connection with other tests a definite local reaction occurs, it should be interpreted to mean the presence of a tuberculous lesion at the seat of the reaction.

The following case illustrates the way in which advantage may be taken of this reaction of physiological chemistry.

G. D., aged 26 years, first came to the Orthopædic Clinic of the Carney Hospital when he was seventeen years of age, having been under treatment for a tumor albus when a child. This had become well enough when he was eight years of age so that he went to school and later entered upon an employment in a fish house which necessitated his being on his feet a great deal. He had no trouble between his eighth and seventeenth years. There was about 35° of flexion of the leg at this time, due to a subluxation of the tibia; beyond this point there was free flexion without muscular spasm; there was also a good degree of knock knee. His occupation compelled him to wheel heavy loads in a wheelbarrow, which put much strain on his knee. Such use was often associated with acute symptoms in the flexed knee, suggesting joint strain. These symptoms would quiet down very promptly after rest, and considerable periods of use of the limb would ensue until again interrupted by joint strain. This state of affairs had recurred so often that it was finally decided to correct the deformities at the knee by means of an osteotomy. While waiting to enter the hospital for this operation, the knee again flared up. This time, however, there was more acute and constant pain and some increase of surface temperature which led to a suspicion that there might be relapsing disease present. Accordingly,

five milligrams of tuberculin were given subcutaneously and there promptly ensued a sharp rise in temperature, headache, malaise, and marked local swelling in the knee, spasm of muscles, redness, and increase in the surface temperature. (Vide chart, Figure 2.) In view of this reaction an excision was decided upon instead of an osteotomy. A small focus of active disease was exposed in the head of the tibia which was unmistakably tuberculous both to gross and microscopic examination.

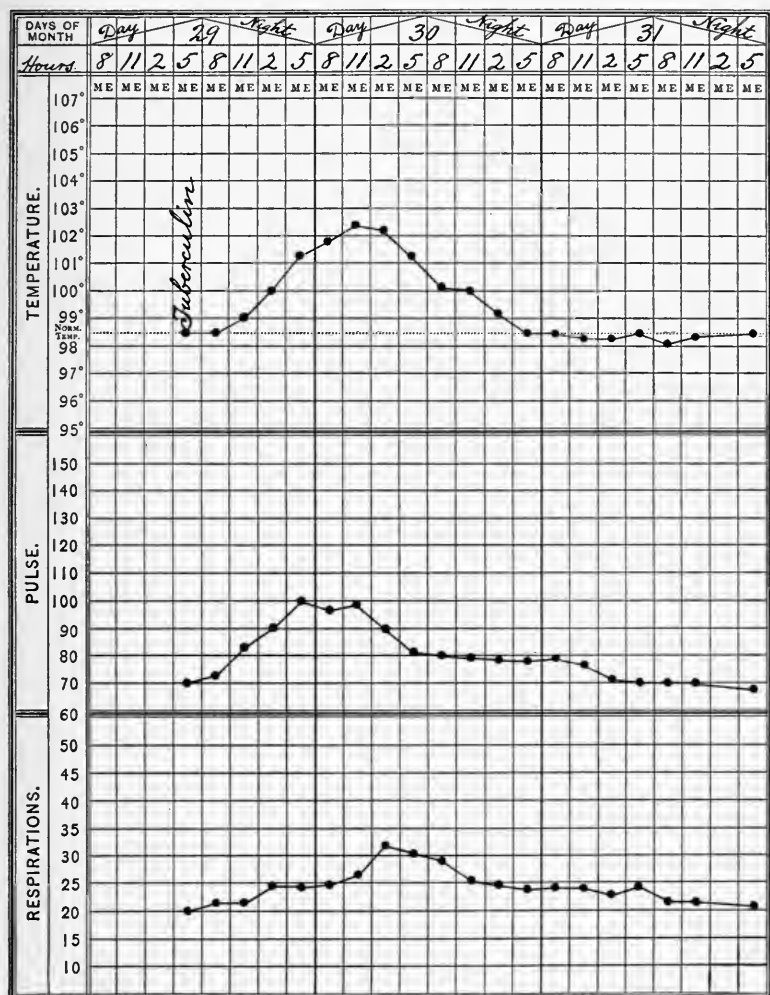


FIG. 2. Chart of Case G. D., showing effect of Tuberculin.

Here is an instance of the value of tuberculin inoculation. An osteotomy would have been a most unfortunate thing to have undertaken, for the reason that the trauma incident to it would have been very likely to have stirred up latent disease.

Other methods of application of the inoculation test have been devised, viz., the Calmette reaction, as practised in the eye, and the von Pirquet percutaneous test. Whatever the value of any tests may be in the recognition of tuberculous lesions, they can be of no practical aid to the orthopædist unless they help him to decide whether a given joint is tuberculous or not. The existence of glandular or other soft-part lesions is so common in the apparently healthy, and so many bone lesions have glandular foci as their starting-point, that a general reaction to tuberculin cannot be regarded as diagnostic when a joint is under suspicion. The dangers of the employment of the Calmette method are considerable, though many continue to employ the reaction.

In the percutaneous method vaccines made from the human and bovine bacilli are being used in an attempt to determine whether a given infection is of human or bovine origin.

**Treatment.** In facing the treatment of osseous tuberculosis the first motive should be to keep the focus confined to the locality in which it originated and increase the patient's constitutional resistance. If to save life it is necessary to sacrifice a leg or an arm by all means sacrifice that part, but first be sure that such sacrifice is necessary, remembering that in a large number of cases such radical measures are not required, and that an organ which may lack even a part of its function is better than no organ at all, or that a member very deficient in function is usually far better than an artificial contrivance, however perfect its construction.

In the treatment of tuberculosis of the bones and joints the condition of the general health is of the utmost importance and should not be overshadowed by surgical or mechanical treatment, even though the immediate results of such measures are much more brilliant. Life in the open air, with an abundance of sunlight, together with bathing and good food, is important, and in general

every detail of hygiene should be supervised with the same care that is considered desirable in the treatment of tubercular disease in the lungs. It is by such measures that the vitality of the individual cell is increased and resistance to the extension of the disease is made possible, and it should be remembered that while these measures are of the utmost importance during the entire course of the disease, they are of importance also throughout the entire life of the individual. If adhered to, this undoubtedly represents the strongest possible defense against a recurrence. An absolutely open-air life in tents or shacks, such as is desirable during the active stage of severe types of osseous disease, is not of course necessary for a permanent mode of living, but proper ventilation of the rooms, plenty of sunlight, adequate bathing facilities, and an abundant amount of wholesome and digestible food, must be secured. Such conditions are always desirable not only for those already affected, but also as the best preventive measure for those liable but not yet diseased.

For internal treatment, aside from a generous dietary, there is little required in the way of drugs, other than such as will relieve special symptoms or improve or aid nutritive processes.

Recent investigations of the diet in tuberculous patients have shown that nutrition is maintained and weight increased more satisfactorily by methods which do not involve "stuffing" the patients by forced feeding. A careful selection of the most easily digested and assimilated foods, their thorough preparation and administration at more frequent intervals and in smaller quantities is a method less likely to induce a disgust for food or disturb the digestion than has been the case with some of the older methods.

**Opsonins.** It is in this connection that an effort should be made in every case in which the tuberculous opsonic index is low to increase it, recognizing the fact that it is in these cases of low opsonic index that control of the disease is most difficult. The principle which underlies the employment of the opsonic test is this. Any organism capable of infecting the body, with certain exceptions, produces toxins, which in turn cause the production of chemical substances

in the blood-serum described as opsonins. These chemical substances stimulate the white blood corpuscles to phagocytosis against the organism which has infected the individual, and theoretically in proportion as these opsonins are capable of exciting phagocytosis the infection will be overcome.

The method of applying this test is as follows: A small quantity (1 - 2 c. c.) of blood is drawn from the patient's ear or finger and centrifugalized. This separates the blood into serum, white corpuscles, and red corpuscles, according to weight. A pipette full of the white corpuscles is withdrawn and washed free of serum in a normal salt solution. A culture of the bacterium which has caused the infection, or is supposed to have done so, is put in suspension in water and a definite quantity of this is mixed with the washed leucocytes; this mixture is then put into a thermostat for fifteen minutes. A stained smear is then made from this mixture and fifty leucocytes are studied, and the numbers of bacteria which are found in each of the fifty leucocytes are added together and an average obtained. A normal blood is then taken as unity and the same bacterial suspension is used and the same number of leucocytes are counted to obtain the phagocytic index of the normal blood. The phagocytic index is divided by the result obtained in the case used as unity and the quotient represents the opsonic index for that patient. This index may be obtained for any organism which is capable of producing local toxæmia. Determination of the test should be of value in diagnosis, and also in planning treatment by the appropriate toxins. Any pathological laboratory should be able to make the tests after a little practice in the special technique. Our first year's experience in using the determination of the opsonic index as a diagnostic aid has been a failure. Tuberculous vaccines employed for the treatment of the osseous forms of tuberculosis have not in our hands proved any more efficient than constitutional treatment alone. We do not however consider that the last chapter of vaccine therapy in bone tuberculosis has been written.

**Local treatment.** The fundamental principle of local treatment

aims at the preservation of function in the affected part. This should be done with the minimum of irritation at the seat of disease. In pulmonary tuberculosis it is not the custom to bind up the chest or in any way to restrict the respiratory function, except in the very acute cases when confinement to bed is temporarily enjoined; on the contrary, life in the open air with considerable moderate exercise is desirable; high altitudes where the respiratory effort must be greater are generally regarded as suitable for phthisical patients; special exercises designed to increase lung capacity are permissible and are advocated up to the point of intolerance.

When treating this disease in bones or joints the same principles should hold, and instead of confining the part absolutely, function should be allowed as in the lung up to the point where subjective and objective symptoms become marked. The degree to which limitation must be enforced must vary with the individual case, owing to the fact that there are different types of disease and different degrees of virulence. It also makes a difference whether treatment is begun early or late and whether there is much or little deformity. Confinement of the affected joint together with its immediate neighbors is a very common practice, notably in hip disease, but it should be avoided as a routine measure, because of the deleterious effect which this has upon the nutrition and the consequent resistance of the part. Only such limitation to function should be allowed as is necessary to control the symptoms in the given case, and aside from this, use should be permitted, in order that circulation and nutrition may be interfered with as little as possible. By so doing, not only is local resistance increased, but healing, even in severe cases, takes place much more rapidly than can be expected where the extent of the limitation of function has made all repair processes sluggish.

In limiting motion the position of the joint should carefully be borne in mind in order that a proper balance of the various groups of muscles may be established, recognizing that this is Nature's protection against deformity, and that if such a balance can be established muscle spasm, which results from over-stimulation

of a non-antagonized muscle, will disappear. At the same time position with reference to ultimate function, in case ankylosis takes place, should be considered.

In the knee the most favorable position to accomplish both of these ends is with the leg extended to within five degrees of complete extension. In this relation the flexor and extensor muscles properly antagonize or balance each other, so that muscle spasm, which is so noticeable a feature during the active stage of the process if the joint is flexed, ceases entirely. This position in case of ankylosis is also most favorable for practical use.

At the hip the best position is with the thigh flexed about twenty degrees, abducted fifteen or twenty degrees, and outwardly rotated about ten degrees. In this position the head of the femur rests most easily in the acetabulum and the various groups of muscles are balanced so that the element of spasm is largely eliminated. This position is not only the most favorable during the active stage of the disease, but it is also the most favorable in case the lesion is so extensive that ankylosis ultimately ensues. In this position flexion and abduction with outward rotation make it possible to preserve the upright position and obviate the rolling gait seen wherever the thigh becomes ankylosed with the least adduction. In standing, flexion is overcome by the increased flexibility of the lumbar spine, while abduction corrects, in part at least, any shortening which may have taken place.

In the spine the most favorable position is that of considerable hyperextension. This overcomes the great disadvantage under which the posterior muscles act when the body is flexed (the usual deformity), at the same time lessening pressure at the seat of disease, with consequent benefit to the general health which must come from the fact that in hyperextension the thorax is expanded, giving greater respiratory movement.

In the ankle the best position is with the foot at a right angle with the leg, in which position the spasm of the gastrocnemius is entirely overcome. In case of ankylosis this position is also a most favorable one for function.



In the other joints the same principles apply, but as these articulations are less frequently affected than those already mentioned, it does not seem essential that they should be specially considered. The joint should be protected during the active stage of disease, and its position during protection chosen with reference to overcoming muscle spasm through a balancing of the antagonizing muscle groups, this at the same time being the best position for ankylosis in case the disease should be so marked as to make this result inevitable.

At times even under the most favorable conditions tuberculous joint lesions do not improve under conservative measures and more radical steps become necessary. This course may also be considered advisable at times when in some exposed part a lesion can be clearly shown to be localized and easy to reach. Under such circumstances, even though the process might heal under conservative means, it is nevertheless wise to extirpate the focus.

The operation which is best to perform in a given case must necessarily depend upon the situation of the disease. If it is located in the joints of the extremities, and there is not only great bone destruction, but extensive involvement of soft parts, with the general health such that it is evident resistance to extension to other parts is nearly exhausted, amputation or entire removal of the affected part may be demanded. In any such case however if the environment previous to this has not been good, at least a short trial under the most favorable general and local conditions should be urged, as under such circumstances even seemingly hopeless cases at times improve markedly. If this be the case, while operation may still be needed, a less mutilating one than amputation may be sufficient to accomplish the desired result.

Excision of a localized area of disease is occasionally possible, but usually, because the involvement is more general than appears on the surface, more extensive operations, such as entire excision of the joint, are demanded.

In the knee this is most satisfactorily carried out. In the hip it is less gratifying, because it is not possible to remove all of the dis-

eased bone, and in the ankle the complexity of the joint, with the frequent extension of the disease to many of the tarsal articulations, makes extirpation of the disease difficult if not impossible. It is to be borne in mind however even in such a case that although all of the disease cannot be removed the condition is not necessarily hopeless, as not infrequently if the larger part of it is removed Nature is able to take care of the rest, and healing promptly takes place.

In any case however whether the disease be located in the knee, hip, or other joint, before an operation is performed the part should be put at rest for sufficient time to allow the process to quiet down, realizing that by so doing the danger of absorption, with extension to other parts, is very much lessened. To still further diminish this danger before the wound is closed the entire operating field, both bone and soft parts, should be generously treated with the Tincture of Iodine, and after its use the wound should be loosely closed, not attempting to establish drainage of a more permanent character than is necessary to allow the escape of the excess of exudate which will follow an operation. It is always well to try for a rapid closure of the wounds, as by so doing the danger of secondary infections is very much lessened. A more detailed consideration of the indications for operation in these conditions will be found in another chapter.

Of the special features more or less frequently met with in all forms of bone and joint tuberculosis, abscess is probably the most common. In dealing with this it is to be remembered that such an abscess is formed by the softening down of the centre of a tuberculous mass; that the wall or periphery of the mass is composed largely of tubercles, and that the increase in the size of the abscess is due to the extension of the disease at the periphery. Such an abscess contains as a rule no other organism than the tubercle bacillus, and is not associated with much rise of temperature or other symptoms indicative of a systemic disorder. Its presence is usually made known, unless it comes to the surface where it is readily seen, not by any special constitutional symptoms, but by interfering mechan-

ically with the function of the part. The joint capsule may be made more tense; a muscle, such as the psoas, may be irritated and contraction result; a nerve, such as the vagus, in case of posterior mediastinal abscess, may be irritated and cause serious cardiac symptoms; an organ, such as the trachea or bronchi, in case of retro-pharyngeal or mediastinal abscesses, or the abdominal viscera in cases of large abdominal abscesses, may be pressed upon and their functions interfered with. These conditions and others of similar nature are often seen, and from the point of view of treatment assume importance. The mere presence of an abscess, provided it is not interfering with the function of some special joint, and provided that it is not a part of a miliary infection, which would be indicated by an elevation of temperature and impairment of the general condition, is of very little importance so long as it is closed. If it could be entirely removed and the primary focus extirpated at the same time, some procedure which had this for its purpose would strongly recommend itself, but when it is remembered that in many cases, in fact in most instances, an entire removal of the primary focus is not possible, free drainage of the abscess is undesirable, since it opens a route for fresh tuberculous infection through the wound and furnishes a mode of entrance for other organisms which are as much to be feared as the primary disease. Many of the deaths which occur in cases of this sort are due to a general septicæmia resulting from secondary infection and are only indirectly due to tuberculosis. For this reason unless there is hope of the entire removal of the disease the abscess should be ignored, until it has come well to the surface or is causing some of the undesirable symptoms mentioned above. In any case, the danger of the secondary infection and the practical impossibility of keeping a discharging sinus clean should always be borne in mind. In children resistance to mixed infections is undoubtedly greater than in adults, but even with them the utmost care should be taken, both at the time of operation and later to keep the process purely a tuberculous one.

If for the reasons given above drainage of the abscess is desired,

it is wiser wherever possible to aspirate for the purpose of removing the excess of fluid, not expecting to destroy the bacilli which are present in the wall of the abscess cavity. This aspiration will probably have to be repeated several times, the intervals depending upon the rapidity of refilling of the cavity. If for any reason the aspiration is not successful, small incisions, one or more, would be the most desirable procedure. In any case however where the abscess represents a mixed infection free incision should be made, the pus evacuated, and the cavity wiped out with Iodine. The tissue should not be torn or mutilated more than is necessary, and a curette should not be used, since all such procedures open up fresh avenues for absorption.

Following this the wound should be loosely closed, leaving a small wick extending into the abscess cavity, which should be removed in from three to four days, the wound being then encouraged to heal although the abscess will undoubtedly refill and at some time later require further attention. Even should this be repeated several times it is better than if a long-continued discharging sinus is allowed, because of the lessened danger of secondary infection.

In certain cases, particularly children, it is possible to clean out a cold abscess by a thoroughly aseptic operation, provided the incision be made through sound tissues removed as far as practicable from the point where the abscess is tending to come to the surface. The interior of the cavity may be wiped out with Iodine, and if any necrosis is accessible it can be eradicated at the same time. The cavity should then be carefully sewed up, without drainage. Dr. Starr of Toronto has advocated this method and reports excellent results.

Another problem which is frequently presented in the treatment of such conditions, and this chiefly as a preventive measure, is the correction of deformities which may have developed in the earlier stages of the disease. A flexed or adducted hip, a flexed knee, an extended foot, all are deformities which result in strain to the part during use, which in the majority of cases if continued will result in the lighting-up of the original disease.

This being the case, even though there may be no evidence of active disease at the time of examination, if deformity is present so that the joint is strained in use, operation for the correction of this should be advised. If active disease is still present conservative measures, such as traction or protection, should be tried first, but if the deformity is seen after the focus is wholly healed, operations, such as subtrochanteric or transtrochanteric osteotomy for hip deformities, supra-condylar osteotomy, wedge-shaped resection, or genuclasis for knee deformities, and the removal of the astragalus or osteotomies of the tibia for ankle deformities, are all of importance, and should be advised under such conditions for the purpose of preventing the recurrence of the original disease.

In the severe types of bone tuberculosis, especially those in which there has been prolonged suppuration, not infrequently amyloid changes take place in the internal organs, indicated by extreme pallor, chronic nephritis, enlargement of the liver, and distention of the abdomen. Such symptoms naturally add much to the gravity of the case, but it must be remembered that not infrequently even these seemingly hopeless conditions are overcome. Treatment in these cases, aside from symptomatic considerations, consists largely in such measures as tend most quickly to improve the general health. Life in the open air should be insisted upon and other details of good hygiene should be observed.

## CHAPTER I

### METHODS OF PHYSICAL EXAMINATION IN JOINT DISEASE

THE success of diagnosis depends largely upon thoroughness in physical examination. It is certainly of no less importance than a painstaking study of a patient's history. Regarded from the point of view of evidence it is direct and positive, liable only to errors in observation on the part of the diagnostician, and these should be avoidable, or to confusion in their interpretation which the really experienced should be able to overcome. Evidence obtained by questioning a patient is susceptible of much distortion. When a disease is chronic the memory of the patient is hazy concerning points which are vital to the diagnostician, and facts which are absolutely unessential are sometimes remembered in profusion and with a clearness which is astounding. Physical examination has been much neglected in the practical handling of joint cases in office practice and in most clinics until within quite recent times. Now that special clinics are organized for the study and treatment of such conditions there is no longer any excuse for failure to search out the physical signs the observation and interpretation of which have been proved to be important in the differentiation of types of disease.

One must not be satisfied with a thorough physical examination. An exhaustive consideration of the clinical course of the disease must also be undertaken. The two should go hand in hand, and in weighing evidence the one should be used to qualify the findings of the other. It has therefore been deemed advisable to consider those methods of examination which have been found most useful in diagnosis.

*ANKLE AND TARSUS*

In this group of joints there are a few which merit more consideration than others. Dorsi- (Figure 3) and plantar- (Figure 4) flexion of the foot take place between the tibia and astragalus; abduction and adduction somewhat at the medio-tarsal joint, which



FIG. 3. Normal voluntary dorsi-flexion of the foot with leg extended

is between the scaphoid and astragalus and the scaphoid and cuneiforms, but chiefly at the calcaneo-astragaloid; pronation, or rotation of the foot upon its long axis, occurs so far as it occurs at all between the astragalus and os calcis. These joints therefore concern us most in considering the diseases and injuries of the foot and ankle.

The following is a convenient method of procedure in the physical examination of the ankle, from the inspection of which much may be learned. If the patient is able to walk he should first be observed standing and walking with the shoes on. The feet should then be bared for the remainder of the examination. Standing and walking should again be inspected. In studying an ankle it should be viewed

from the front and from the back with the feet parallel to each other and separated an inch or two. (Figure 5.) A part of the examination can be conducted with the patient in the sitting position, but it is difficult to eliminate muscular resistance when sitting facing the patient and holding the foot with the knee extended. Involuntary muscular resistance, which has nothing whatever to



FIG. 4. Normal voluntary plantar-flexion of the foot.

do with muscular spasm but may simulate it, can best be excluded by making the patient stand on one leg, flexing the leg which is to be examined and resting it upon a stool in the flexed position, so that with one foot the patient stands on the ground and with the other leg he is resting upon the anterior surface of his tibia. In order to satisfactorily accomplish this the stool must be the same height as the knee joint of the leg upon which the weight is being borne. The manner in which the weight is borne as indicated by the places where the shoe has worn, and the relation of the foot to the leg as indicated by the presence or absence of "running-over" of the shoe, may be studied in the shoe after its removal.



The points to be observed are enumerated below :

INSPECTION	{	Gait
		Attitude in standing
		Relation of long axis of foot to long axis of leg
		Muscular power; Subcutaneous fat; Weight
		Relative size of legs and feet
		Bony prominences and deformities
		Color. Congestion { active
		passive
		Perspiration
		Swelling — Location of
		Calluses — Character and location
		Height of longitudinal arch { with weight
		without weight
PALPATION	{	Condition of anterior arch
		Deformities of toes
		Muscular tone
		Muscular spasm
		Surface temperature
		Character of swelling
		Bone
		Fluid
		Capsular
		Mobility:
		Active
		Passive
		Range and character of limitation in motion
		Oedema
		Tenderness
		Callosities — Situation of
		Reflexes
		Condition of blood vessels

Besides these special points which should be noted in every examination of the foot, search should be made for signs of deformity

or the evidence of diathetic disease in other parts of the body. The condition of the thoracic viscera and the functioning capacity of the kidneys have frequently to be determined. A knowledge of the presence or absence of sugar in the urine is often necessary for diagnosis.

A brief consideration of the points enumerated may serve to emphasize their diagnostic importance.

### INSPECTION

**Gait.** Disturbances in the gait may be due to paralysis of the muscles of the leg and foot; to inflammations in or about the joints of the tarsus or ankle; to bony spurs so located as to be irritated by pressure of the shoe or the act of weight-bearing; to partial ankylosis of some of the tarsal joints caused by erosions within these articulations, spur formation at the edges of the articulations, or to inflammation of these joints through static derangements. Such disturbances in gait are all more or less alike in their general characteristics and cannot readily be described.

**Attitude in standing.** Habitual standing position is of much significance in the etiology of disturbances in the statics of the feet.

**Relation of long axis of foot to long axis of leg.** A disturbance of the relations of the leg to the foot is of more importance in the determination of symptoms than the mere height of the arch. Normally the weight of the body is borne through the long axis of the tibia which meets the long axis of the foot a little to its inner or median side. When the ligaments and muscles tending to maintain this relation are stretched or over-fatigued, disturbance of this relation may occur and symptoms result.

**Muscular power. Subcutaneous fat. Weight.** Muscular power and general muscular tone should be studied. Loss in tone is as a usual thing part of a general process, and in such cases can be detected by palpation more readily than by inspection. Tests of the power of the different muscle groups should be made to determine whether there is any diminution or complete absence of power,

and in unilateral cases comparison should be made with the sound side. Experience in making such examinations gives one a standard of motion, making it unnecessary to refer to the standards laid down in text-books. Individual anatomical peculiarities must be counted on when their existence is known. Flexors, abductors, adductors, and extensors should all be tested.

The weight of a patient and his height are worthy of attention. The relative amount of subcutaneous fat and the rapidity or slowness with which it has been acquired should be given due consideration.

**Relative size of legs and feet.** Atrophy of the thigh and calf should always be looked for as well as

differences in the size of the two feet. Disuse, paralysis, and interference with growth may be responsible for this condition.

**Bony prominences.** Bony prominences may be the result of irritative exostoses caused by pressure or toxic influences, or may be caused by fractures of the tarsal bones, by disease, or by congenital and paralytic influences.

The regions where they are most common are upon the os calcis, beneath the infra-Achilles bursa, at the insertion of the plantar fascia into the os calcis, on the dorsum of the foot anywhere from the juncture of the astragalus with the scaphoid down to the articulation between the first and second phalanges. Hypertrophy



FIG. 5. This man had low arches in both feet, which accounts for the prominence of the inner borders of the feet below and in front of the malleoli. The left ankle had been recently sprained. Compare this with the right and note the obliteration of the fossæ on either side of the Tendo Achillis. The margins of the Tendo Achillis are not well seen on the left.

of a ridge of bone on the dorsal surface of the distal end of the first metatarsal produces a deformity known as *hallux rigidus*. Spurs due to fracture are generally on the body of the os calcis or astragalus and overhang the joints between the os calcis and astragalus and scaphoid. Bony prominences connected with congenital defects are the result of the long-continued malposition of the tarsal bones. They are generally noted about the medio-tarsal articulation and are associated with valgus or varus. Diseases of an inflammatory character, as for example tuberculosis and tumors of bone, may cause osseous prominences in the tarsus.

**Color. Congestion.** Passive congestion of the foot is of frequent occurrence in any of the static disturbances to which it is liable. It is characterized by slight swelling without œdema and a bluish discoloration. Active hyperæmia is generally confined to the toes and possibly a short way up on the metatarsals, and is commonly due to some vaso-motor affection of the vessels of the foot. Great venous distention is commonly seen in the acute and subacute troubles of the feet.

**Perspiration.** Abnormal perspiration is seen in most cases of static and other disturbances of the feet during their most acute stages. After inflammatory diseases of the tarsus — e. g., gonorrhœal arthritis — cold, clammy perspiration is frequently noted, standing out in beads on the surface of the toes. It will re-form nearly as fast as it can be wiped away.

**Swelling.** The usual location of swellings about the foot and ankle is as follows. The joint between the first metatarsal and the phalanx, the corresponding joints of the second and third toes, the dorsum of the foot over the joint between the internal cuneiform and the base of the metatarsal articulating with it, and the joint between the cuneiform and scaphoid and between the scaphoid and the head of the astragalus, the base of the fifth metatarsal, and also the head of the fifth metatarsal. These swellings may be bony, capsular, or bursal. On either side of the ankle joint and in front of the tips of the malleoli are frequently seen two rounded swellings which are usually overgrowths of a fat pad which is normal to that

region. Annular swelling encircling the ankle at the level of the malleoli is generally capsular, but may be fluid, and is indicative of ankle joint disease. That portion of the peroneal or posterior tibial group of tendon sheaths which are immediately below and behind their respective malleoli are frequently swollen. The fossæ on either side of the body of the astragalus and just above the posterior end of the os calcis are most frequently obliterated by osseous, though occasionally by inflammatory, swellings. The sheath of the Tendo Achillis becomes distended and on either side of its insertion into the os calcis and in front of the lower one and one-half inches of the tendon is often found a semi-fluctuant swelling which is generally bursal.

On the inner border of the foot, below and slightly anterior to the internal malleolus, a swelling is frequently seen partly obliterating the posterior span of the longitudinal arch. This is very characteristic of valgus and is not osseous or capsular in its character, but apparently a purely static condition. Swellings on the sole of the foot are generally confined to the point where the plantar fascia is inserted into the os calcis, to the substance of the plantar fascia itself, and to the region beneath the ball of the great toe, where a bursal enlargement sometimes occurs about the sesamoids.

**Calluses.** Calluses are caused by disturbances in the statics of the feet, by pressure of the shoes, and by papillomatous changes. Papillomata are frequently multiple and are usually on the plantar surface of the feet, most frequently on the ball of the foot, but may be on the heel. They are sometimes called "seed warts." The ordinary "corns" are on the dorsal or lateral surfaces of the joints of the second phalangeal articulations, usually on the fifth toe, but in paralytic and congenital hammer toe they may occur on all the toes. Soft corns between the toes are frequently caused by the crowding together of the digits and the consequent maceration of the skin.

Calluses caused by disturbances in the method of weight-bearing are noted beneath the balls of the toes, along the inner surface of

the heel where the skin of the plantar surface of the heel shades into the softer skin of the side of the foot, and on the inner side of the distal phalanx of the first toe where the foot rolls to the inner side in a pronated position.

**Height of longitudinal arch.** The height of the longitudinal arch is subject to great variation and apart from other signs or symptoms is valueless. The method of determination of its height by wet tracings of the sole of the foot is futile. The height of the transverse arch may be judged somewhat by the relative breadth of the anterior portion of the foot, by the existence of a callus between the first and fifth toes, and by the presence of an hallux valgus. Hallux valgus rarely occurs without a depression of the anterior arch; callosities however may be present without any other evidences of breaking down of this portion of the foot. Increase of apparent depression of the longitudinal and transverse arches when weight is borne is of some significance.

#### PALPATION

**Muscular tone.** As has been stated, this is best determined by palpation. Flabby and "soft" conditions of the general muscular system may be of great influence in the causation of symptoms of joint strain.

**Muscular spasm.** This splinting of the joints occurs in all inflammatory diseases and its presence in certain articulations while it is absent in others is frequently of great aid in localizing an inflammatory process. It is usually present in the tarsal articulations because attempts at weight-bearing keep the muscles in a continual state of irritation. It is not always indicative of inflammation however, but may be due to the irritation of a joint strain, as in acute valgus with peroneal contracture. In such cases it can sometimes be partially or wholly overcome by a steady though gentle application of force in a direction opposite to that in which the spasmodic contracture is pulling. Its persistence may result in permanent deformities.

**Surface temperature.** This is increased in all inflammatory pro-

cesses and in most static and metabolic disturbances where there is congestion. Over inflamed bursæ it is common. In some neurological conditions and in vaso-motor disturbances, as well as in hypertrophic lesions of the leg and foot, the surface temperature may be below normal and patients also complain of a subjective sensation of cold.

**Character of swelling.** Palpation is the best way of determining the nature of a swelling. Bony prominences are usually recognizable in this way, though differentiation between a very tense bursa and a cartilaginous or even bony thickening may be confusing. Infiltration of the capsule is also most readily determinable in this manner. Bursæ are circumscribed and their most common location is over the joint between the first metatarsal and its adjoining phalanx, beneath this joint between the sesamoids and the skin, over the corresponding joint of the fifth toe, beneath the os calcis, and in front of the lower end of the Tendo Achillis. In congenital and paralytic club foot there is frequently a large bursa over the cuboid upon which the patient treads. Teno-synovial swellings are most common in the Tendo Achillis, the peroneals, and the posterior tibial, occasionally in the sheath of the extensor longus hallucis and the anterior tibial. The sheaths of these tendons may contain ganglia, though this is more rare than in the tendons of the hand.

Fibrous and fatty fringes may be palpable in tendinous sheaths. Large accumulations of fluid are not possible in the joints in or about the tarsus.

**Mobility. Range and character of limitation in motion.** Active mobility should always be tested with resistance. It is thus possible to determine whether limitation in the arc of motion exists, to what extent, and whether it is accompanied throughout by spasmodic resistance or is merely obstructed at some particular point by a mechanical obstacle.

**Oedema.** Oedema is suggestive, if bilateral, of cardiac or renal disease or of some venous stasis. It should invariably lead to a determination of the condition of the heart, kidneys and blood vessels.

**Tenderness.** Tenderness to pressure is often significant of inflammatory processes, of bony exostoses, of irritated bursæ, and of the strain of tendons upon their osseous insertion, producing a localized periostitis.

**Callosities.** Callosities yield very little more information upon palpation than has already been cited upon inspection. It is important to discriminate between the ordinary "corn," or thickening of the horny layer of the epithelium, and the "seed wart," or papilloma.

**Reflexes.** The reflexes at the knee and ankle should be tested, and the presence of Babinski's sign and ankle clonus should be sought in cases where any suspicion of involvement of the central nervous system is entertained.

**Condition of blood vessels.** Arterio-sclerosis and vaso-motor contractures of the vessels are capable of giving rise to peripheral disturbances in the feet, and must be taken into account. In hyperæmias of the foot the presence or absence of pulsation in the dorsalis pedis and posterior tibial should be determined.

### *KNEE JOINT*

The knee joint offers an excellent opportunity for physical examination. It should be observed in action and at rest, both from the front and from the side. It is a hinge joint with the possibility of flexion to such an extent that the back of the heel may be made to rest upon the buttock in individuals who are not too fat or muscle bound. There is no lateral motion possible in the joint when the leg is completely extended and only a very slight amount when the leg is flexed. Occasionally in persons who are muscularly relaxed there may be a slight amount of hyperextension of the knee. The trochlear surface of the femur is higher on the outer than on the inner side, but in relaxed conditions of the capsule or elongations of the patellar tendon the patella is more mobile toward the outer than toward the inner side of the joint; occasionally it actually slips off the trochlear surface of the external condyle. In women there



is a tendency toward knock knee because of the greater width of the pelvis.

In studying the diseases of this joint it will be found useful to investigate the following points:

INSPECTION	{	Gait
		Attitude
		Mobility :
		Active
		Passive
		Deformity
		Color
		Swelling
PALPATION	{	Evidences of Arthritis elsewhere
		Muscle Spasm
		Surface Temperature
		Character of Swelling
		Capsular
		Fluid
		Osseous
		Comparative Measurements
		Examination of Tendon Sheaths and Bursæ
		Limitation in Motion — Causes of
		Tenderness

#### INSPECTION

**Gait and attitude.** The limp which is associated with trouble in or about a knee joint may be due either to deformity, ankylosis, or spasm. In standing, patients try to spare the knee by bearing weight on the well leg or plantar-flexing the foot on the side of the affected knee so as to tread on the toes alone.

**Mobility.** First, active (i. e., voluntary) mobility should be tested, and then passive motion should be tried. Often a considerable degree of motion may be secured on passive examination, whereas no motion is possible when voluntarily attempted. In some condi-

tions, e. g., tabes, there is a hypermobility on passive examination. Lateral motion should be impossible in a completely extended knee.

**Deformity.** Deformity at the knee joint, when distinguished from swelling of bone or soft parts, is due to some disturbance in the relations of the bones of the joint to each other. Flexion, hyperextension, knock knee, and subluxation of the tibia are the principal deformities. These are not always found as single deformities. There may be combinations of two or more.

**Color.** Anything disturbing the capsule of the knee joint, unless it be a more or less acutely inflammatory process, is very likely to blanch the skin through interference with circulation. In consequence of this the term *tumor albus* has been applied to tuberculous disease of the knee joint. Other than this there are no peculiarities of color changes to be noted. Redness as one of the cardinal symptoms of inflammation occurs here, as elsewhere, in acutely inflammatory conditions. Ecchymosis after hæmorrhage into a joint, either traumatic or in consequence of hæmophilia, causes characteristic modifications in the color of the skin over the joint.

**Swelling.** There are normally, as is shown in Figure 6, even in quite stout persons, two fossæ on either side of the patella which become obliterated when there is either capsular thickening or excess of fluid. Enlargement of the knee joint may be due to bony changes, to capsular thickening, or to the presence of an excess of fluid, distending the capsule. The quadriceps pouch or bursa, as it is sometimes called, extends four or five inches above the upper border of the patella when the leg is extended and is in reality a part of the joint. There are other bursæ which frequently communicate with the knee joint and share with this articulation any swelling that may be primary in it. These are the infra- and pre-patellar bursæ, and one beneath the inner hamstrings. There is also one under the lower end of the tendon of the biceps. The enlargement may be symmetrical and involve the entire joint or it may be confined to some particular part of the articulation. Even the popliteal space is occasionally invaded by swelling which may

represent distention of the capsule or enlargement of the bursæ which communicate with the joint. The upper, outer quadrant of the joint and that part which is just below the inferior border of the patella and on either side of the patellar tendon are most likely to exhibit localized soft-part swellings. The lower end of the femur or the upper end of the tibia may be asymmetrically enlarged. This is particularly true of inflammatory conditions. Tumors more commonly distend the whole bone and may or may not be smooth in contour. The patella when it becomes enlarged is not symmetrically swollen. The normal fat pads on either side of the patellar tendon are sometimes hypertrophied and may represent a mechanical obstruction to the free use of the joint.



FIG. 6. Normal contours of knee in a muscular subject. Note the hollows on either side of the patellæ and the slight fullness below the patella made by fat pads. Fluid, bony or synovial enlargements may distend the capsule of the joint and obliterate these fossæ.

Evidence of arthritic lesions in other joints should be carefully sought as a part of the routine examination.

#### PALPATION

**Muscle spasm.** Muscular spasm is at once brought out by attempts at passive motion. The hamstring tendons may be felt as well as seen in a condition of spasmodic contracture. As a rule in the more

acute cases, muscular spasm holds the affected joint rigid against all motion. Occasionally in less active processes spasm is only elicited in a part of the normal arc of motion. Limitation in motion may be wholly due to spasm, but it may also be caused by the mechanical obstacle of a bony spur or some deformity which has disturbed the relations of the component bones of the joint.

**Surface heat.** Surface temperature should be tested by touching the skin with the back of the hand and comparing with the unaffected joint. It is not significant of inflammatory changes only, but is noted in metabolic or purely traumatic lesions.

**Character of swelling.** Palpation is the best method of determining the character of an interarticular swelling. Diffuse infiltration of the synovial membrane is detected by the greater sense of resistance to touch which can be appreciated in the affected knee. Localized fatty and villous thickenings are also detected in the same manner, as they have a different quality of resistance in themselves. Osseous and cartilaginous thickenings are differentiated with greater difficulty, but are usually suggested by their resistance, location, and lack of mobility. The so-called "joint mice" which are free in the cavity are usually of this bony or cartilaginous nature. Fluid, when thin and serous, is readily recognizable by its fluctuation, but when thick and viscid or containing much inspissated fibrin is frequently indistinguishable from the finer villous changes which occur in some forms of chronic arthritis. Aspiration of the joint is often resorted to in such cases for diagnosis. Cytological studies of the fluid withdrawn by aspiration have not proved of value as diagnostic aids.

In bone tumors deep palpation will sometimes reveal "egg shell" crackling and irregularities on the surface of the bone indicative of either the myelogenous or periosteal forms of sarcoma. In all cases of bony thickenings Bence-Jones (albumose) bodies should be sought in the urine.

*HIP JOINT AND PELVIC GIRDLE*

Examination of the hip joint and the articulations between the ilium and sacrum next demand attention. In the former there is a considerable range of motion in several directions. The norma



FIG. 7. Illustrates the normal amount of voluntary flexion of the thigh; also the obliteration of the lumbar curve when in this position. The amount of flexion varies considerably according to the amount of fat on the individual, his occupation, physical activity and age.

motions of the hip joint, so far as they can be graphically illustrated, are shown in Figures 7 and 8. There is but slight normal mobility at the sacro-iliac joints. Strains, injuries, and diseases are liable to attack these articulations as they do other joints.

INSPECTION	{	Attitude
		Gait
		Deformity
		Swelling

	{ Spasm
	{ Surface Temperature
	{ Swelling — Location and Character of
	{ Motion
PALPATION	{ Active
	{ Passive
	{ Tenderness
	{ Atrophy
	{ Comparative length of limbs

### INSPECTION

**Attitude.** A patient with hip symptoms should be examined undressed. The standing position viewed from the side and also from the front and back give valuable information. After the standing position has been studied and the gait observed, then recumbency, both prone and supine, should be assumed and the examination continued. The standing attitude may reveal a prominence of one hip over the other, a difference in the height of the anterior superior spines, an exaggeration of the lumbar curve, a flexion of the thigh, and assumption of positions tending to relieve the affected limb of its share in weight-bearing. This may influence the whole carriage of the individual. When the pelvic girdle is concerned there may be a decided list of the entire trunk to one or the other side, a prominence or a recession of the sacrum, and simple flexion of the trunk or a combination of flexion and lateral deviation of the spinal column. Such listing changes the contours of the sides in such a way as to exaggerate the concavity of one side at the waist line and to diminish it upon the other side. Rotation of the thigh, either in or out, and its deviation either toward or away from the median line are oftentimes notable.

**Gait.** A hip gait is generally an easy one to recognize. Its cause is found either in a more or less complete ankylosis and restriction of motion or in deformity and interarticular sensitiveness. The stride is shortened and often the patient walks upon the toes of the affected side, and in many instances exhibits a rolling gait.



FIG. 8. Showing normal flexion of thigh with extended leg. This would not be quite as great if right thigh were extended, and still less if the foot were not slightly plantar-flexed.

**Deformity.** Deformity at the hip joint may consist of permanent flexion, abduction, adduction, or rotation, and displacement of the femoral head from its socket, the more common displacement being upwards upon the dorsum of the ilium.

**Swelling.** Swelling may be localized below or above Poupart's ligament, on the anterior or lateral aspects of the thigh, or in the gluteal region. Prominence of the trochanter may be notable. This may be due in part to osseous thickening and in part to an atrophy of the thigh and gluteal muscles. The relation of the trochanter to a line (Roser-Nélaton's) drawn from the anterior superior spine to the tuberosity of the ischium should be noted. The trochanter should be just on or below this line. The relation of the head of the femur to the femoral vessels should also be determined. There may be a diffuse swelling of the entire upper third of the thigh instead of a localized swelling to which allusion has just been made. This swelling may extend over to the pelvic side of Poupart's ligament.

### PALPATION

**Spasm.** Muscular spasm may concern all the muscles about the hip in a reflex way or it may be confined in its activity to one or two groups of muscles. Motion of a sensitive joint causes much pain as well as muscular spasm. Under ether, spasm of this kind disappears.

**Surface temperature.** Surface temperature has the same importance here as elsewhere and evidence of its increase should always be sought.

**Swelling.** Palpation reveals deep-seated swellings and their character, whether fluid or solid. Particularly important is it in this connection in determining the existence and character of swelling and induration on the pelvic side of the hip joint and the bursæ beneath the gluteal muscles and between the psoas and iliacus. Tenderness along the line of the sacro-iliac ligaments is frequently noted and in some cases a click may be detected on attempting motion at these joints.

**Motion.** The normal standard of motion for the individual under examination should be determined for the well leg when this is possible as a preliminary to the examination of the affected side.



Active motion should next be tried in flexion; then in abduction, both in a flexed and an extended position of the thigh; then in rotation, both outward and inward. (Figure 9.) Hyperextension is a very important motion to be tested and is best accomplished when the patient is in a prone position. In acutely inflamed joints the patient can make no voluntary motion at the hip. Flexion of the thighs with



FIG. 9. Showing normal outward rotation of the left thigh. Normal inward rotation of right thigh. These are voluntary in both cases. Slightly more inward rotation could probably be secured if force were exercised.

extended legs should be tried in order to test for sacro-iliac lesions. The hamstring muscles are put on the stretch when the leg is extended. These muscles are attached to the innominate bone and when the muscles are made taut they then pull on the ligaments uniting the sacrum and ilium.

**Tenderness.** Tenderness to pressure and on attempted movement of the joint is in many cases significant of deep-seated inflammatory processes on the one hand and cartilaginous erosions or interarticular abscesses on the other.

**Atrophy. Shortening.** Atrophy of muscles and the comparative length of the legs both real and apparent (Figure 10) should be investigated with the tape measure. Atrophy of the thigh and calf are visible as well as palpable and the use of the tape measure is

only necessary for purposes of graphic comparison. Atrophy of the glutei and obliteration of the gluteal fold are notable in hip joint troubles. Atrophy is usually less in sacro-iliac joint diseases and relaxations than it is in diseases and deformities about the hip joint itself, but involves the same groups of muscles.

### SPINE

The spine is maintained in the erect position by a carefully balanced set of muscles.

When spinal symptoms are to be investigated the patient should be undressed, and the examination should be made with the individual standing, and then recumbent, both prone and supine. Active motions of the spine should be performed in order to study the carriage and flexibility of the spine.

The following points should be observed :

INSPECTION	{	Attitude
		Motion — Limitation of and Location
		Deformity
		Swelling
		Spasm
	{	Respiration
PALPATION	{	Muscular Spasm
		Swelling — Character and Location of
		Tenderness

**Attitude. Deformity.** Spinal deformities are caused by postural or structural changes. (Figure 11.) The normal physiological curves of the spine are subject to some variation in different individuals, but in general there is a well-defined lordosis in the lumbar region with a rounded kyphosis in the dorsal region. Under various conditions, these curves, one or all, may be wholly obliterated or considerably exaggerated, or one may be blotted out entirely while another may be much exaggerated. Bony deformities may be sharp and angular

involving one or more vertebræ, or they may be rounded. They are generally confined to one region, but occasionally there are two kyphoses. It must be remembered that the seventh cervical vertebra and one or two in the mid-dorsal region and occasionally one at the juncture of the lumbar and low dorsal portion of the column may be prominent without having any pathological significance. Disease in different regions of the vertebral column produces more or less characteristic attitudes which are caused by alterations in the physiological curves. Lateral deviation of the spine as a whole without compensatory S-shaped curvature generally results from some irritative cause outside the spinal column, either in the sacro-iliac joints or



FIG. 10. Note the anterior superior spines and that they are equidistant from the umbilicus. Measurements from these two spines to the internal malleoli, when different, show the "real" shortening. Distances measured from the umbilicus to the malleoli, when different, indicate apparent shortening, due to tilting of the pelvis and either abduction or adduction of the thigh.

below them or within the pelvis or abdomen. Greater prominence of one side of the trunk is generally due to a rotation of the vertebræ upon their long axes. This may occur on both sides of the spinous processes but in different regions of the column, one being primary and the other compensatory. Twisting of the



FIGS. 11 and 12. This series illustrates the normal curves of the spine in a healthy adult. These are subject to some variation in men and women, but any considerable disturbance in their contour is significant.

head associated with contracture of one sterno-mastoid or of other groups of muscles concerned in the maintenance of the head in an erect position may produce a symptomatic torticollis. In determining the causes for this, cervical and mediastinal glands, carious teeth, suppurating middle ears, pediculi capitis, ocular defects, facial asymmetry, congenital contracture of the sterno-mastoids,

and vertebral disease must be looked for. Defects of vision are a common cause and should be carefully considered. In the search for the causes of deviations and deformities of the column below the cervical region it is necessary to examine the chest for evidence of pleurisy and intra-thoracic growths, abscesses or non-suppurative conditions, emphysema, and aneurisms.

In the abdominal region intra- and retro-peritoneal glands, in-



FIGS. 13 and 14. Observe the location of the axis upon which the trunk bends and the symmetry of this bending. The amount of side bending is not subject to variation under normal conditions, but the point at which it takes place may vary a good deal.

flammations of the appendix, aneurisms, new growths in the intestine with vertebral metastases, or any visceral disease may cause either a structural or a postural deformity of the spine. Measurements of the length of legs should always be made in lateral lists of the spine and scoliotic deformities. The condition of the knee reflexes should be tested and ankle clonus and Babinski's sign should be looked for.

**Motion.** Limitation in the motion of the spinal column is of much significance. (Figures 12, 13, 14, 15.) In inflammatory diseases

of the bony column there is early spasmodic restriction in motion. When there is kyphosis this restriction is at the seat of the deformity most markedly, but to a greater or lesser extent on either



FIG. 15. Showing normal flexion of trunk and the symmetry of the trunk on either side of the spinous processes.

side of it. The patient should be made to pick up articles from the floor in order to note whether the spine bends or is held rigidly. In acute conditions the patient uses the hands to climb up his own thighs on rising from a stooping position, or else that position is assumed by bending the knees and lifting the desired object from the side. In inflammatory conditions involving the ligaments of the column the entire length of the spine may become ankylosed with or without alteration in the physiological curves. In these cases there is no motion in any direction. Respiratory excursion should be measured in all cases and notice taken of the extent to which respiration is abdominal. In diathetic conditions, e. g., the hypertrophic type of arthritis, motion will be guarded in certain directions while entirely free in

the opposite direction, or instead of the maximum lateral motion taking place at the customary level it will be found to take place at a higher level than normal, or at the normal height in one direction and at a higher level in the other direction. Hyperextension of the spine should also be tested.

**Swelling.** Swelling, apart from deformity, in spinal diseases, is generally indicative of abscess. These usually manifest themselves in the lumbar region on one side or the other of the spinous processes, occasionally bridging over the median line. Most, though not all of these localized abscesses are "gravity" or "cold" abscesses. Those which originate above the diaphragm may point in the thoracic region. Local heat, redness, and fluctuation characterize them. Mediastinal abscesses characterized by "grunting" respiration, acceleration of the respiration, and dry cough, most marked when the patient is recumbent, are of occasional occurrence, and always of serious import.

### PALPATION

In examining the spine more is learned from inspection than by palpation. In the prone position tests should be made of the flexibility of the spine. This is accomplished by lifting the legs from the table and hyperextending the trunk. In the hyperextended position the trunk should be flexed laterally in both directions. Fluctuation should be sought for in swellings having the appearance of abscesses. Tenderness in some of the deep-seated collections of fluid beneath the lumbar aponeurosis speaks for suppuration. When the patient is supine careful palpation of the abdomen should be practised in a search for evidences of suppuration, glands, aneurisms, and neoplasms.

### SHOULDER GIRDLE

The bones comprising the shoulder girdle consist of the clavicle, the scapula, and the humerus. Examination of this region necessarily concerns all these bones and the articulations between them.

The following points should be observed in examining the shoulder girdle:

INSPECTION	{	Deformity
	{	Active and Passive Motion
	{	Swelling

PALPATION	{	Spasm
		Local Temperature
		Swelling—Character of
		Motion—Amount of
		Tenderness
		Glands
	{	Crepitation

### INSPECTION

**Deformity.** Comparison of the height of the scapular angles should be made. The size of the two scapulæ should be compared. Prominence of one inferior scapular angle over the other may indicate the presence of a rotation of the vertebræ or a paralysis of some of the scapular muscles. Differences in the height of the shoulders may be only a natural condition or it may be indicative of underlying defects. The position of the arm and hand with reference to the body should be observed. The location of the head of the humerus should be studied and atrophy of the muscles of the scapula, shoulder, and upper arm should be noted in comparison with the well side.

**Motion.** Mobility of the arm at the shoulder should be observed and the range of this motion, independent of movement of the scapula, should be particularly noted.

**Swelling.** Swelling about the shoulder girdle may be diffuse, due to inflammatory processes or neoplasms, often involving the axilla and scapula, or it may be localized over the point of the shoulder as in cases of inflammation of the subacromial bursa.

### PALPATION

Muscular spasm is present in acutely inflammatory conditions within the shoulder joint and may cause a practical ankylosis of this joint. Periarticular or bursal inflammation may produce the same effects. Motion is preserved in some of the latter cases in a certain portion of the normal arc but not throughout its entire extent. The lymphatics from the shoulder region drain into the



axillary glands and enlargement of them in inflammatory processes about the shoulder is very common. The subacromial bursa is a very large one, and only that portion of it which is immediately over the point of the shoulder is usually injured or inflamed. Fluctuating swellings, except in the axilla, are not very common about the shoulder. Tests of muscular power and reflexes should be made in order that paralytic conditions may not be overlooked.

Local tenderness should be sought and increase in surface temperature should be tested.

Crepitation over the scapulæ and about the shoulder joint should be looked for, particularly when marked round shoulder exists. Flexion of the portion of the scapula which is above the spine quite frequently occurs and in such conditions the superior scapular angle rubs against muscles overlying the ribs, causing crepitation and sometimes pain upon motion of the shoulder.

### ELBOW

The elbow joint is of considerable interest in physical examination. Its bony prominences are near the surface and their relation to each other, whether normal or otherwise, is easy of determination.

The examination of the elbow joint may be systematized in this way:

INSPECTION	{	Deformity
		Mobility
		Swelling
		Atrophy
PALPATION	{	Spasm
		Character of Swelling
		Surface Temperature
		Tenderness
	{	Glands

## INSPECTION

**Deformity.** Deformity should be first investigated. Permanent flexion at the elbow, permanent pronation or supination of the forearm, and luxation deformities of the radius and ulna upon the humerus are the commonest of these. Inflammatory diseases are the cause of the first two, while congenital and paralytic conditions are responsible for the other. Traumatism may also cause deform-



FIG. 16. Showing the normal voluntary flexion of the elbow.

ities, most conspicuous of which is the "gun stock" deformity following fracture at the elbow joint. The effect of the "gun stock" deformity is to interfere with the carrying function of the arm, causing fatigue and disability.

**Mobility.** Active mobility should next be studied. (Figure 16.) The motions taking place at the elbow are flexion, extension, pronation, and supination. (Figure 17.) They should all be tested and comparison made with the sound side.

**Swelling.** Swelling at or about the elbow is usually due to inflam-

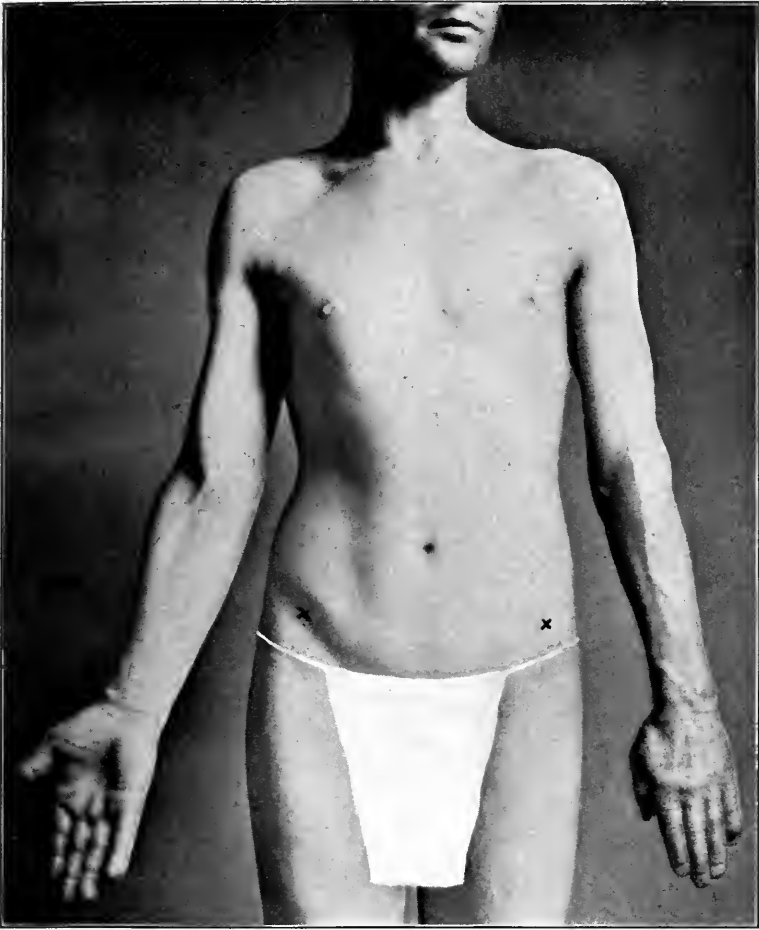


FIG. 17. Showing the normal amount of voluntary pronation and supination of the hands. Both arms are completely extended and the right hand is in extreme outward rotation, while the left is in extreme inward rotation, the humeral condyles being in the same vertical plane.

matory or neoplastic processes within one or the other condyle of the humerus or in the radius or ulna. Sometimes the swelling is due to a distention of the medullary cavity of the shafts of the bones entering into the composition of the elbow joint. The shape of these swellings is generally that of a spindle. Capsular thickening or accumulations of pus or serum may enlarge the joint and fill in

the fossæ on either side of the olecranon and cause a fullness to appear in the flexure of the elbow. Pallor, passive congestion, or hyperæmia may be present according to the nature of the swelling.

**Atrophy.** Atrophy of the muscles of the arm and forearm and even of the shoulder and scapula may be seen in cases of disease or injury to the elbow. Its more definite determination may be left to comparative measurements. Flabbiness of the musculature should always be suggestive of the existence of atrophy and lead to careful investigation.

### PALPATION

**Spasm.** Muscular spasm is an early sign of disease in or about the elbow joint. It may wholly restrict the motion of the joint and cause its permanent deformity or only partially restrict motion and cause very little permanent deformity.

**Character of swelling.** The character of the swelling is best determined by estimating the resistance of the deeper tissues and making comparison with the same part of the opposite joint. Fluctuation, though often deceptive, is of service in determining the existence of fluid. The presence of loose bodies in the joint should be sought.

**Surface temperature.** Increase in surface temperature characterizes the changes caused by disease and injury to the elbow, and should, of course, be comparative. The hand is a sufficiently accurate measure for this purpose.

**Tenderness.** Tenderness over bony prominences and over any swellings about the joint, as well as tenderness brought out by attempted motion, should be noted.

**Glands.** Enlarged glands, epitrochlear and axillary, are frequently found in diseases in or about the elbow.

### CARPUS

The joints of the carpus and hand present conditions somewhat like those in the tarsus and foot. The joints most frequently dis-

eased are those between the carpal bones and between the radius and the carpal bones. The presence of large and important tendons which pass close over the carpal articulations add an element of anatomical interest not possessed by the tarsus.

The following points should be observed in the examination of the wrist:

INSPECTION	{	Deformity
		Mobility
		Swelling
		Atrophy
PALPATION	{	Spasm
		Character of Swelling
		Tenderness

#### INSPECTION

**Deformity.** The deformities to which the wrist is susceptible are flexions, ulnar deflections, subluxations, and occasionally osseous deformities caused by fractures and dislocations. Congenital deformities are not uncommon here. The others to which reference has been made, aside from the traumatic ones, are caused by disease.

**Mobility.** Comparative measurements of the motion in flexion, extension, and lateral bending should be made. (Figures 18, 19.) There is always possible less radial deflection than ulnar. Deformity of the fingers frequently accompanies disease of the wrist.

**Swelling.** Swelling may be due to fluid or villous changes in the synovial membrane of the carpal joints or to teno-synovial swellings. Localized enlargements which are superficial are frequently ganglia. Sometimes swelling of the carpal articulations will appear on the palmar side, sometimes on the dorsal side of the wrist only.

**Atrophy.** Atrophy is a marked feature of the diseases of the wrist and hand, and is not confined to the forearm, but frequently manifests itself conspicuously in the interossei.



FIG. 18. Normal voluntary dorsi-flexion of the wrist.

### PALPATION

Palpation enables one to distinguish between synovial and osseous thickenings. It helps in the recognition of the existence of fluid accumulations, and detects ganglionic enlargements on the tendon sheaths and the creaking of teno-synovitis. It assists in the recognition of rice bodies and gives evidence of muscular spasm on passive motion, thus assisting in the localization of inflammatory processes in individual articulations.

### JAW

The articulations of the jaw are rarely affected and special methods of examination do not need discussion in this place.

After all has been said it is occasionally necessary to resort to other methods of examination than those which have been cited here. The application of the X-ray to the study of diseases of the joints demands special consideration. The employment of tuberculin and other vaccines for the diagnosis of tuberculous and non-



FIG. 19. Normal voluntary flexion of the wrist.

tuberculous diseases of the joints has been referred to in the appropriate place. The so-called "therapeutic" tests are invoked in such diseases as syphilis and rheumatism. Their employment is mentioned here chiefly to condemn their use. Diagnosis should be made without them, and if reliance is placed upon them failure will inevitably result in many cases, and frequently in those where it is most undesirable that it should so result. Ether examination, to which reference has been made, is frequently of assistance, causing a disappearance of muscular spasm and permitting a more satisfactory examination. It will be useful for this same purpose to enforce rest in bed and fixation of a joint until acute symptoms have quieted down.

Great thoroughness in the general examination, in order that no important physical defect may be overlooked, cannot be too strongly urged. The greatest importance of all should attach to a careful consideration of the history of the patient, both immediate and past, together with hereditary influences, viewed in the light of the physical examination.

## CHAPTER II

### TUBERCULOSIS OF THE SPINE. POTT'S DISEASE

TUBERCULOSIS of the spinal column, or Pott's Disease, is the most common form of tuberculosis in bone. The osseous disease usually appears in the centrum of one or more vertebræ. Occasionally a focus will be found just beneath the periosteum at or about the line of juncture between two adjoining vertebral bodies extending thence in either direction just beneath the anterior common ligament, this latter type being characterized often by little deformity. The disease usually appears in the bodies of the vertebræ, rarely in the laminae. Any region of the spine may be affected, the dorsal being the most common, the lumbar next, and the cervical least frequently of all. Dorsal cases predominate over cervical in the proportion of five to one and over lumbar as three to one. The greatest mobility of the column occurs at the dorso-lumbar juncture and it is here that Pott's Disease is of most frequent occurrence.

As the process develops, the diseased portions of the vertebræ soften, and when these softened areas can no longer support the superincumbent weight, that portion of the body which is above the seat of disease settles down upon the necrosed bone and intervertebral discs. When this occurs the articular processes of the vertebræ, which are rarely affected, and which are situated well posterior to the vertebral bodies, do not allow the posterior portions of the spine to settle, and as the softened area is in front of these articulations, the body bends forward. In consequence the back becomes rounded, and the spinous processes at the seat of disease are made more prominent, until as it progresses a "knuckle" or humpback deformity is produced. The types heretofore described are primarily osseous. A third type represents what is apparently a direct infection of the vertebral body from contiguous tuberculous lymphatic glands.



Here only the lateral portion of the bodies may become eroded and as one side only is affected, or one side more than the other, a lateral deviation of the spine occur. This is shown pathologically



FIG. 20. Illustrates the usual central origin of an osseous focus in the vertebræ. Observe the outlines of a prevertebral abscess, the fusion of two vertebræ, the 9th and 10th dorsal, obliteration of intervertebral disc, lateral list of the column, and approximation of the ribs attached to diseased vertebræ on the right.

in Figure 20. The intervertebral discs are seldom, if ever, the primary seat of disease, but become disintegrated as the adjoining vertebræ break down. Because of the greater liability of boys to traumatism we find that many more males than females are affected. It is at once apparent that this is not a true curvature, there being in it no element of rotation.

## ETIOLOGY

The most important contributory causes of tuberculosis of the spine are contagion, trauma or debility, and heredity. Their importance is probably about in the order given.

**Contagion.** It is now generally conceded that of these three, contagion is the chief etiologic factor in the dissemination of pulmonary tuberculosis. The evidence of direct infection of bone from a pulmonary case is naturally more difficult to secure than that of the transmission of tuberculous infection from one phthisical patient to another. Inasmuch as such infections are not necessarily direct from lung to lung, but may be through the tonsils or other portals of the lymphatic system before the lung itself is attacked, it would seem that the same intermediary stage might intervene in cases of osseous infection whose primary source was the lung of some member of the patient's family or others closely associated with him. The upper air passages or the alimentary tract are doubtless most often the channels of entrance. Tuberculous glands in various parts of the body may break down, emptying into the lymphatic system a mass of infective detritus which later finds in the blood stream an efficient carrier. The bacilli may pass through the intestinal mucous membrane without producing any ulcerative lesions upon its surface, just as Goodale has shown that they may pass into the tonsil without giving rise to any evidence of their presence. In view of the demonstrable relation of osseous vertebral lesions to mesenteric tuberculosis it seems not unreasonable to suppose that in the thoracic region tuberculous processes in the lung or pleura or possibly in the mediastinal glands may extend to the dorsal portion of the column.

**Trauma.** The relation of trauma to bone tuberculosis is a very intimate one in the minds of the laity, and it is probably true that it plays an important part as a contributory cause. There are very few cases from whom a history of trauma may not be obtained. There is often a considerable interval between the trauma and the beginning of symptoms. In adults relapses are frequently directly

traceable to a well-defined traumatism. Several striking instances of this have come under the observation of the writers.

J. H. A., male, aged twenty-seven years. Seen May 20, 1902. Diagnosis: Pott's Disease. Pott's Disease at six months of age. Wore apparatus intermittently until he was eighteen years of age. Always worked on farm, and though "hired out as a boy he did a man's work." Owns and operates a farm alone now. Tipped out of sleigh in February, 1902, and struck on shoulder and back. Since then has been in bed a good deal of the time. About two or three weeks ago first noticed abscess, which has steadily increased. Some numbness in legs, particularly the right. General health very good. Paralysis thirteen years ago in both legs; laid up for some months. Lumbar abscess of large size.

**Heredity.** The influence of heredity upon the development of Pott's Disease is not that of the direct transmission of a tuberculous infection through the maternal circulation or through the male elements of reproduction. There is no reliable evidence of the occurrence of such transmission from parents to child.

The existence of phthisical lesions in a family has the effect of lowering the vitality of that family and in this manner paves the way for subsequent infection by the tubercle bacillus.

## PATHOLOGY

Microscopically the lesions of Pott's Disease are identical in appearance with other tuberculous lesions. It is not necessary here to discuss them.

The gross lesions of tuberculosis in the vertebral column show a ragged erosion deep in the substance of the vertebræ, usually in one or more adjoining ones. The erosion, if primarily central, works its way anteriorly. The sides of the eroded area in the bone are jagged and covered with grayish tuberculous granulation tissue, over the surface of which may be seen thick yellowish pus in which are often scattered granules of cheesy detritus. The anterior ligaments of the

column are lifted away from the affected vertebræ and the space thus made is often occupied by an abscess, the walls of which are lined with the same tuberculous granulation tissue that is seen over the surface of the osseous erosion. This abscess may extend along the front of the column for a considerable distance before finally perforating the fascia and getting to the surface along the lines of least resistance.

The intervertebral discs, when adjoining vertebræ are involved, disintegrate and melt away as a part of the abscess. Careful examination will often show miliary tubercles scattered over the surface of the granulation tissue lining the cavity containing the abscess. The vertebral canal is rarely narrowed by osseous overgrowth, but extension of tuberculous granulation around and into the canal may narrow its lumen.

Repair processes consist in a transformation of the granulation tissue into a fibrous scar tissue and the partial obliteration by this fibrous material of the cavity made in the bone. Osseous regeneration does not go on to any considerable extent. Calcification of residual abscesses and embedding of such calcifications in fibrous tissue are frequently seen at the site of tuberculous lesions in the spine.

### SYMPTOMS

The symptoms upon which the diagnosis of Pott's Disease is made vary considerably, especially those which are subjective. In any well-marked case, however, though some one symptom may be lacking, there are usually enough others present to make the diagnosis possible. In well-marked cases there is a characteristic *deformity*. The greatest danger lies in failure to appreciate the fact that an antero-posterior deformity of the spine is not as a rule the earliest symptom of Pott's Disease and furthermore that cases of this disease may go through their entire course and never show such a deformity. Of the common earlier symptoms the following are the most important.

**Pain.** There is great variability in the occurrence of this symptom.

It may be quite severe, causing much suffering, and on the other hand it may be entirely lacking, though this is very rare. In children the pain is not usually referred to the spine, but more frequently to the abdomen. In adults pain is a more constant factor, and is referred most often to the back, frequently radiating to the legs, due



FIG. 21. Note the sharp angular character of the kyphosis, apparently confined to one or two spinous processes. The lumbar curve is almost wholly obliterated and the normal forward bending of the dorsal spine is exaggerated. The trunk is considerably shortened.

undoubtedly to pressure upon the posterior nerve roots. Pain is increased by sudden motion such as a jar, fall, or mis-step, a cough or a sneeze. During sleep spasmodic pain is not infrequently complained of, the patients waking with a sharp, involuntary scream, the so-called "night cry," and while this is less common than in tuberculosis of the hip, it nevertheless occurs with considerable frequency in children; more rarely with adults. Pain is a conspicuous feature of those more unusual cases of Pott's Disease in which there



FIG. 22. Showing the exaggerated lumbar lordosis accompanying dorsal disease. The focus of disease is situated higher in the dorsal region than in Fig. 21. The lordosis is exaggerated in the lumbar region, whereas the anterior curve of the dorsal spine is lessened.

is no deformity; it is in such cases that the character, behavior, and distribution of pain may be of particular diagnostic significance. This symptom is nearly always worse at night in tuberculous disease, because voluntary muscular control is lost in sleep. The pain which accompanies high dorsal and cervical disease is referred oftentimes to parts quite remote from the kyphos.

In adults there is one symptom which is quite significant among the earlier signs. The patients frequently notice a pronounced disability which manifests itself when they

undertake to make some motion involving the use of the trunk muscles. This disability is not dependent upon the pain produced by attempts to make the given motion, but seems to be caused by a muscular incapacity. The disability in Pott's Disease is often intermittent.

**Attitudes.** In the child that which usually first attracts the attention of parents is a peculiar attitude in walking or standing. The spine is held rigidly while walking or bending, because a reflex muscular contraction is induced by the disease. Involuntarily the



FIG. 23. Views of the type of torticollis characteristic of cervical Pott's. Observe the contraction of the right sterno-mastoid. In a congenital torticollis of this type the left sterno-mastoid would be most on the stretch. Spasm of the posterior muscles is responsible for this deformity.

muscles try to protect the necrotic area from being pressed upon, since by such pressure pain is induced. Attitude is in a measure dependent upon the situation of the disease and its stage of activity. Attitudes in tuberculous caries in the acute stage are produced by spasmodic contraction of muscle in such a manner as to obliterate the physiological curves of the spine in certain regions and to exaggerate them in others. In the chronic stage of the disease when the kyphos is well marked, that portion of the spine is ankylosed; the attitude resulting from such ankylosis is essentially different from that seen in the acute stage. The modifications of the normal curves of the

vertebral column which ensue when erosions take place in the vertebræ assist very much, when properly interpreted, in arriving at a diagnosis. The nearer the sacrum the disease occurs the less will be the actual deformity, but the normal lumbar lordosis (Figure 21) will be largely obliterated. If the disease is higher up, particularly in the mid- and upper-dorsal regions, the lumbar lordosis (Figure 22) will be greatly exaggerated. The shoulders are often thrown back, causing the patient to assume a "military position." At times, owing to activity of the disease, or because it is more marked upon one side than another, the body is inclined to one side; when this occurs in



FIG. 24. Illustrates the extreme sensitiveness of the spine. The child is holding his flexed thigh across the well one and steadying and supporting his body weight with his right hand.

the cervical region it often gives rise to a torticollis. (Figure 23.)

In standing the arms often seek some support, and frequently this is obtained by placing the hands upon the thighs. On rising the spinal motions are all guarded and the body is assisted in gaining an upright position by the aid of the arms. The hands are placed at first on the knees (Figure 24) and slowly, by a climbing motion, the body is elevated. Patients with

cervical disease frequently rest the chin in the hands to steady the head and in some measure to lift the weight off the diseased vertebræ.

**Knuckle or Kyphos.** Upon examination a prominence of one or more of the spinous processes can be detected, indicating the seat of disease in the bodies of the vertebræ to which these spines belong.



In the early stage this prominence or knuckle is sharp (Figure 25), but as the process extends and other vertebræ become involved, it becomes larger and rounded. (Figure 26.) The deformity is usually simply an antero-posterior bend of the spine, but occasionally, owing to the fact that the disease is more active upon one side than the other, or because of greater spasmodic contracture upon one side, there is lateral deflection. When this latter feature is present, it can easily be differentiated from simple lateral curvature by the lack of rotation, by the limited section of the spine involved in the knuckle, and by the spasm of the muscles at the seat of the deformity. The development of the kyphos necessarily calls for considerable readjustment of thoracic viscera and blood vessels.



FIG. 25. Showing the sharp angularity of acute Pott's involving one or two vertebral bodies. Same case as shown in Fig. 21. Observe the change in the two curves, dorsal and lumbar. In this case the patient was standing, but was being strongly supported.

The aorta is frequently greatly distorted; the lungs, trachea, and larger bronchi may be so compressed that respiration is more rapid than normal. The resulting tortuosity impedes the normal flow of blood, and has been mentioned as a cause for retarded growth in cases of marked deformity. In the cases where marked kyphosis is present there is often extreme forward projection of the sternum and flattening of the ribs on either side of this bone. In these cases also the iliac crests are likely to be flaring and the ribs to settle inside them. (Vide Figure 36.)

**Limitation of motion. Muscular spasm.** In tubercular disease of the spine, motions, both active and passive (Figures 27, 28, 29, 30), are distinctly limited at the point of infection, and this limitation is present whether the patient is prone or standing. In the early or acute stage limitation in motion is due to muscular spasm, representing an involuntary contraction of the muscles adjacent to the



FIG. 26. An old healed case. Note the rounded kyphos involving several spinous processes. Contrast with Fig. 25. The trunk is much shortened.

diseased area. This spasm serves to protect the part from violence. Being muscular, it disappears under anæsthesia, but in the later stages, after healing is well advanced, there is bony or fibrous ankylosis, and limitation in motion is present under all conditions. At times the muscles upon one side are irritated more than those upon the other, and as a result the whole body is drawn to one side. This occurs most often when the disease is located in the low lumbar and sacral regions (Figure 31). When it is in the cervical spine torticollis is common. (Vide Figure 23.)

In the lumbar region, irritation of the psoas muscle is frequently followed by contraction, so that hyperextension of the thigh is limited. While there may be contraction upon both sides, it is usually more marked upon one. (Figure 32.) Active bending of the spine brings out markedly the restriction in motion, as is well seen when the child attempts to pick up objects from the floor.

In many of the very acute cases with disease in the dorsal region muscular spasm interferes with respiratory function. Breathing is

shallow and guarded, or short, jerky, and grunting in character. Unless associated with an abscess, this peculiarity in breathing



FIG. 27

FIG. 28

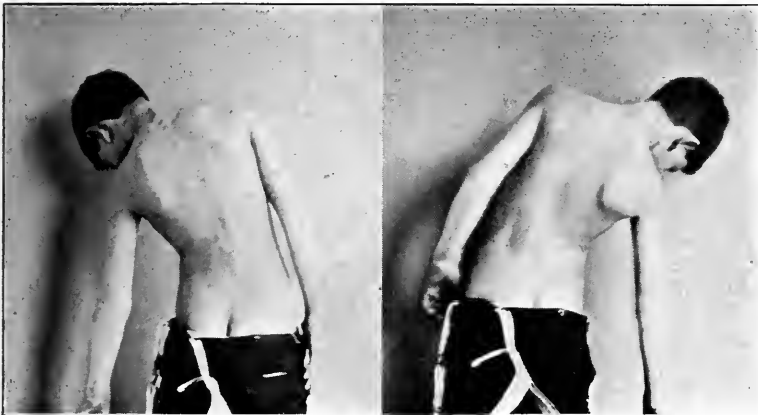


FIG. 29

FIG. 30

FIGS. 27, 28, 29, 30. This series of illustrations demonstrates the limitations in motion occurring in a case of incipient Pott's Disease in the low dorsal spine. Observe the obliteration of the lumbar curve and slight kyphos without any lateral deviation (27). (28) Note restriction of normal flexion and the straight dorsi-lumbar spine (29) and (30) side bending in both directions does not occur at the usual place but rather above the kyphos and to a much diminished amount.

disappears as soon as the acute stage of the disease has passed.

## LATE SYMPTOMS

**Abscess.** At some period in the course of every case of Pott's Disease there must be in all probability a cold abscess. The majority of them, probably seventy per cent, are cared for by natural processes. An appreciable number are recognizable but never come to evacuation, spontaneously or otherwise. A considerable number are of sufficient magnitude to require special attention some time during their course. The position and appearance of such abscesses depend

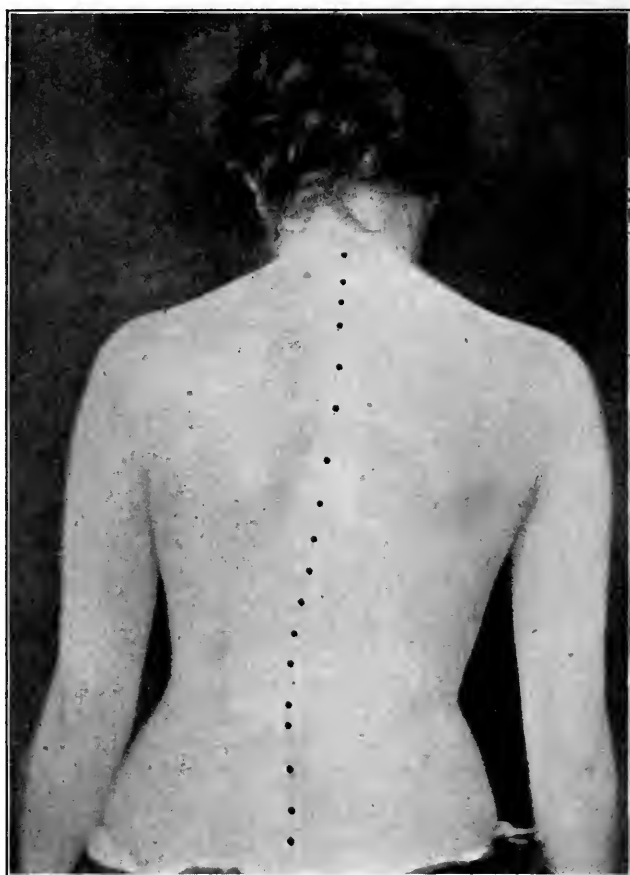


FIG. 31. Showing lateral deviation, a rare occurrence in tuberculosis of the spine ; usually seen before the formation of a knuckle, and occurring in cases where the lesion is in the lateral aspect of the vertebral body or in a transverse process.

upon the location of the disease. If in the low dorsal or lumbar region, it most often shows in the groin just above Poupart's ligament, having followed the course of the psoas muscle in coming to the surface, and for this reason is designated "psoas abscess." It may burrow under the ligament and appear in the thigh (Figure 33) or may point in the iliac region.

In a certain number of cases the abscess works through the muscles and fasciæ of the back and appears upon one side of the



FIG. 32. Showing extreme psoas contracture due to the presence of an abscess in the sheath of this muscle. The thigh is much swollen, due to a second abscess which has gravitated to that region. Observe the sinus on the side below the kyphos.

spine as a lumbar or dorsal abscess. (Figure 34.) It may also extend through the sacro-sciatic notch and come to the surface upon the outer aspect of the thigh.

When the disease is in the upper dorsal region abscesses may first appear in the posterior mediastinum and occasionally press upon some of the important structures in that situation and cause serious difficulty. In a number of instances sudden death has resulted from such pressure upon the pneumogastric nerve. Rarely this abscess discharges through the bronchi; again it may open into the pleural cavity, or work through between the ribs and point in the back, or it may break through the diaphragm into the abdomen, while still more rarely it works up into the neck and discharges there. A few instances are on record where an abscess having its origin in the spine has ulcerated through the bowel and been evacuated through the rectum. More rarely still have they opened into the bladder.

When located in the cervical region the abscess usually appears upon the side of the neck. In a considerable number of cases it opens into the back of the pharynx as a retropharyngeal abscess, while occasionally it gravitates to the mediastinum.



FIG. 33. Note the swelling of the thigh, due to spinal abscess which has penetrated beneath Poupart's ligament.

The presence of an abscess is frequently not detected until it has come to the surface. In the psoas region it can often be palpated behind the abdominal organs when it is forming. The presence of

an abscess is suggested when a lateral deviation develops, whereas before there had been a kyphos only. Unilateral contraction of the psoas or some other muscle or group of muscles also suggests abscess formation. When an abscess occurs in the posterior mediastinum a paroxysmal cough, frequent attacks of dyspnoea, relieved



FIG. 34. Note kyphos in mid-dorsal region with large lumbar abscess immediately below it and to the right.

by change of posture, may be present and are very suggestive. With disease in the cervical region difficulty in swallowing should lead to an examination of the pharynx for a possible retropharyngeal abscess, while a rapidly developing torticollis in a patient who had previously been doing well should also arouse one's suspicions.

The lateness of abscess formation is a fact always to be kept in mind. In adults particularly, abscesses are prone to appear years after a tuberculous process has seemingly been wholly arrested. In adults also the abscesses of tuberculous disease of the spine constitute a more serious complication than they do in children, as they are more likely to become infected secondarily.

**Paralysis.** In a considerable number of cases of Pott's Disease, either as a result of the forward bending of the body or from direct extension of the disease to the membranes of the cord and the infiltration of tissues which necessarily takes place as a part of such a process, the spinal cord is pressed upon and partial or complete paralysis of the body below this point ensues. Tubercle bacilli may actually invade the cord itself, either through the medium of tuberculous granulation tissue or a cold abscess. In most cases the paralysis is in the nature of a paraplegia, both sides of the body being affected, although occasionally one side is affected more completely than the other. This is more frequently seen in adult cases. Paralysis is much more apt to develop when the disease is in the cervical or the upper half of the dorsal region than when situated lower down. The largest number of cases occur from the third to the seventh dorsal. The paralysis is usually spastic, but may be flaccid.

The location will in some measure determine the extent of the paralysis. If at or above the lower third of the dorsal spine, the sphincters of the rectum and bladder may be involved. If in the upper part of the cervical region, the movements of the arms and thorax may be interfered with, as well as the lower portions of the body. Sudden compression of the cervical cord in cases of high cervical disease may terminate fatally. Sensory paralysis, though not always present, does quite frequently succeed the motor paralysis, and disappears first.

## DIAGNOSIS

As a rule if the examination be thorough the diagnosis of tuberculous caries is not difficult. Kyphosis, together with limitation of



motion (Figures 28 et seq.), is always suggestive; when these symptoms are combined with a characteristic attitude in standing or rising, the presence of night cries, pain of the character and



FIG. 35. Arrow indicates the location of focus of disease in the lateral aspect on the body of the first lumbar vertebra. Observe the obscuring of the line of demarcation between this vertebral body and its fellow next above. A large abscess formed from this as a focus and from it a guinea pig was experimentally infected with tuberculosis. Patient has recovered without deformity.

location just described, and all associated with the history of a chronic process, there is little room left for doubt. Further confirmation may be derived from a skiagram. Abscess or paralysis is naturally not to be expected if the examination occurs in the

early stages of the disease. Occasionally, while the fact that the spine is diseased may be recognized, the exact pathology of the lesion cannot be determined. Under such conditions a short period of observation, during which the spine should be fixed, will usually make the problem clear, but if this is not possible and it becomes a matter of serious importance in treatment, tuberculin may be used subcutaneously in the manner described in chapter I, page 15, or the opsonic index be repeatedly tested. The latter is not likely to be of much service and in spinal infection results are less easy to obtain from the use of tuberculin than they are in other locations. During this period of uncertainty treatment should be carried on as if a tuberculous process were present. In this way no harm can come to the patient whatever the diagnosis may prove to be.

**Radiograph.** The radiograph as a part of the examination of Pott's Disease may be of much value, both for purposes of differentiation and of localization of the disease. While it is more difficult to obtain satisfactory radiographs of the spine than in more exposed parts of the body, they are nevertheless of assistance both in the incipient stage and when the process is far advanced, and should be used wherever it is possible. At times a definite ulceration (Figure 35) or destruction of bone can be detected, while at other times an indistinct outline of the bone, with swelling of the peri-articular tissues and obliteration of the space usually occupied by the intervertebral disc, is suggestive. Abscesses frequently cast shadows which are of value in diagnosis. (Vide Figure 20.)

## COURSE OF THE DISEASE

### PROGNOSIS WITHOUT TREATMENT

Without treatment tuberculosis of the spine is a progressive lesion, being limited finally by such conditions, either natural or acquired, as tend to relieve pressure and irritation at the seat of the disease. At first progression is so slow that the patient is usually able to keep about, suffering only moderate discomfort. Gradually

however the symptoms become more pronounced, and quiet, either sitting or lying down, becomes necessary. Pain and sensitiveness to motion increase, and the knuckle, which at first was sharp and angular, gradually, due to the extension of the process and the softening down of neighboring vertebræ, becomes rounded and more prominent.

As these changes take place in the vertebræ, the trunk shortens, and the organs of the thorax and abdomen are interfered with, both as to position and function. The ribs are usually forced downward and forward, the sternum at the same time becoming more prominent (Figure 36), and the ribs are often so crowded together that the intercostal nerves are pinched, causing much pain when not in an extended posture. This latter feature is particularly apt to be noted when the body is so much shortened that the ribs are crowded against the pelvic bones. (Figure 37.)

Months or years may elapse before the deformity has reached such an extreme. If the process is very acute all symptoms are exaggerated; if slow, the entire process is more insidious and attended with less suffering.

Without treatment abscesses and paralysis are very much more likely to develop. Abscesses may appear on the surface and be spontaneously evacuated, or discharge internally, as has already been described, while the paralysis, because of the enforced rest, gradually disappears in the majority of cases.



FIG. 36. Front view of case illustrated in Fig. 37. Note prominence of chest and the fact that the anterior superior spines are on the same level, the lower ribs being wholly inside the wings of the pelvis. The ribs are crowded together, the total height much diminished, and the abdominal and thoracic viscera much compressed.

As a final result, if visceral tuberculosis does not develop or septic absorption from the sinuses take place (the two most common causes of death), the fistulæ heal, other symptoms disappear, and cicatrization becomes complete, after which the patient is well except for the deformity and such general symptoms as may result from this. There is of course a possibility of a recurrence of this same tuberculous process in future years.

#### PROGNOSIS WITH TREATMENT

As a result of treatment, the course of Pott's Disease may be very materially modified. All of the symptoms may be made less severe; the development of abscesses and paralysis is of less frequent occurrence; an increase of deformity can usually be prevented, and the length of time necessary for accomplishing a final result may be much shortened. Whether, however, one or two or five or six years may be required for treatment will depend upon the resistance of the individual and the type of the disease. Rarely is it possible to discontinue treatment in less than two years, while more often three or four are required. Disease in the cervical region, where the vertebrae are smaller, generally requires a little shorter time for healing than in the regions lower down, though the dangers from lesions in this region are greater. As a general rule rigorous protection by jacket or brace need not be continued as long in adults as in children, particularly in non-suppurative cases, since the exaggeration of the deformity by growth does not need to be considered.

#### TREATMENT

In considering the treatment of tuberculosis of the spine too great emphasis cannot be laid upon the hygienic conditions under which the patient should live. An abundance of fresh air and sunlight with life in the open, made possible even in the winter by tents or shacks, bathing, good food, reasonable exercise, are all of the utmost importance because of the improvement which such measures must produce in the general health of the individual and because of the

consequent increase in the power to resist extension of the disease. In this connection, in case the opsonic index is low, an attempt should be made to raise it as described in chapter 1.

For local treatment the principles which are of chief importance are first the protection of the diseased area from any irritation which might be caused by exercise, and second hyper-extension of the trunk.

The need of the first principle is at once apparent, because unrestricted use would aggravate the disease and cause an increase in all symptoms.

The second is perhaps less apparent, but even more important, and involves the first to a considerable degree. Normally when the body is erect there is a proper adjustment or balance between the bones, the joint structures, and the muscles, so that the weight is borne easily with-

out special strain upon any one part or to any one structure. As soon, however, as the body bends forward, as it must at the seat of disease, the posterior muscles, because obliged to pull round the angle of the knuckle, work at a distinct disadvantage, and the balance between the extensors and flexors, which is Nature's protection against deformity, is lost. Not only do the anterior muscles, because improperly antagonized, draw the body forward, but the force of gravity also, as soon as the forward inclination begins, tends to still further increase this inclination, so that the weight thrown upon the bodies of the vertebræ is greater than normal. Since this



FIG. 37. Lateral view of extreme grade of tuberculosis of the spine, illustrating prominence of chest.

portion of the spine is the seat of disease, the softening and disintegration of bone makes it less able than formerly to carry the weight, so that after the process has once started all of these factors tend to aggravate the disease and increase the deformity.

The first principle of treatment, that of protecting the diseased area from the irritation caused by too free use, can be accomplished in any way that will lessen the general activity of the individual. The more exact local protection is usually achieved in connection with measures employed for hyperextending the spine.

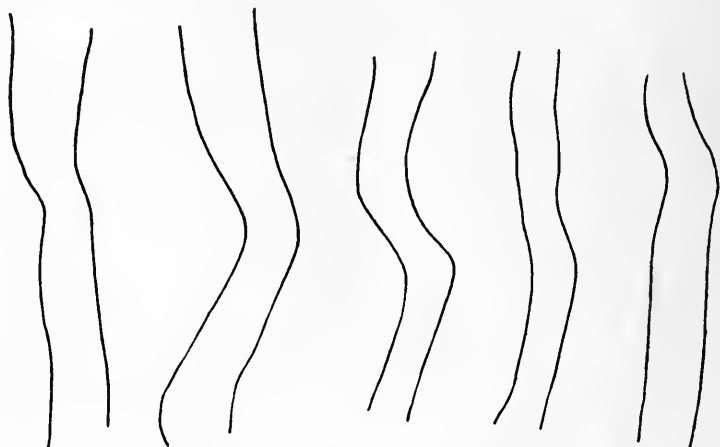


FIG. 38. This series of tracings shows that correction of the deformity by forcible measures is only apparent and is due to changes in the compensatory curves and not in the original deformity. Each pair of tracings from left to right indicate the curves in five cases before and after correction by hyperextension.

The second principle is not always easy to enforce, but involves some form of brace or support which will throw the spine into the position of hyperextension, in which position the anterior muscles can act less advantageously in producing a kyphos, and by changing the centre of gravity the weight thrown upon the diseased vertebræ is necessarily lessened. It was at one time supposed, when the principle of hyperextension was first used, that in this position the diseased surfaces of bone were separated, but as the result of later study it has been quite clearly demonstrated that while in the acute stage of the process when hyperextension is first applied it does

actually separate the bones, this lasts only for a short time, and even though a most perfectly fitted support is worn the bones come together as before, the apparent change in the position being due to changes in the compensatory curves above and below the knuckle. This is clearly shown in a series of tracings presented by one of the writers in a discussion upon the "Forcible Correction of the Deformities Resulting from Pott's Disease" held by the American Orthopedic Association in Washington, May, 1900.<sup>1</sup> (Figure 38.) Not only is it true that the diseased surfaces are not permanently separated, but it is probably desirable that such separation should not take place, since healing would be retarded and would be much less firm than if they were in contact.<sup>2</sup> The process of healing then results in firm ankylosis. To render such ankylosis more secure apophyseal ligation with silver wire has been practised by French surgeons, but without any striking successes.



FIG. 39. Illustrates the effects of bad deformity upon the general appearance of a patient. This photograph was taken twelve weeks before Fig. 40.

The principle of hyperextension is of the utmost importance,

<sup>1</sup> *Transactions of the American Orthopedic Association*, vol. xiii, p. 42.

<sup>2</sup> Calôt, although abandoning forcible correction under ether, has devised a method for application of plaster jackets. The trunk, shoulders and neck are encased in plaster. As soon as the jacket has hardened a small window is cut over the chest. This is enlarged the next day so that the chest and abdomen may protrude through the opening. At the same time a window is cut over the kyphos and by inserting sheets of absorbent cotton through this window the deformity may be gradually corrected.

whether it be accomplished with the patient upon his back on a frame or prone upon a slack hammock or suspended by an extension apparatus or "kyphotone" and pressure exerted against the kyphos by "pellottes" incorporated in a jacket. Throwing the upper part of the body backward raises the ribs, expands the chest, permitting deeper breathing and consequent improvement in general health. The change which this last feature represents is strikingly

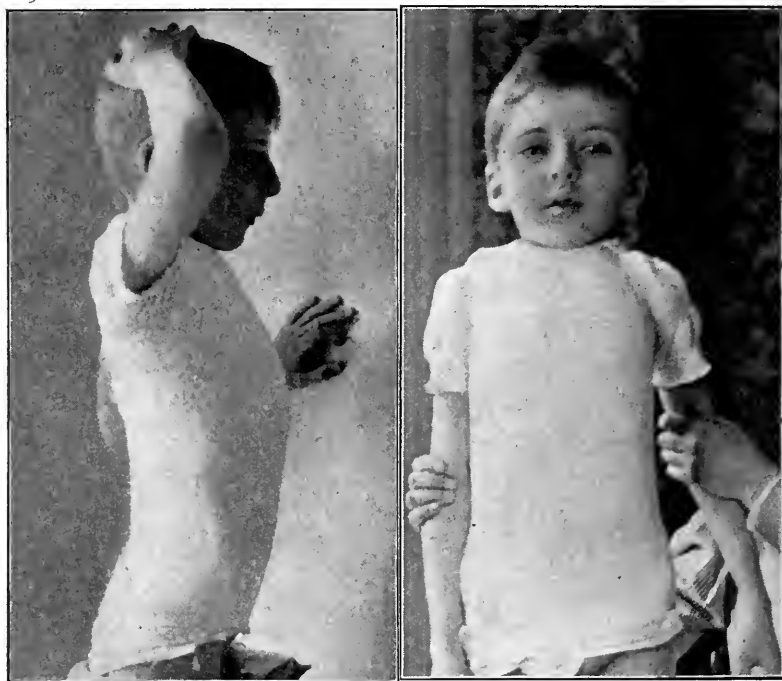


FIG. 40. Compare with Fig. 39. This photograph indicates the improvement which occurred in this patient within a few weeks (12) after the application of a jacket.

shown in Figure 39 and Figure 40. The second picture was taken twelve weeks after the first, the treatment in the interval consisting in correction of the attitude by hyperextension, in which position the respiratory and digestive functions were more perfectly carried on. The gain in nutrition as is shown in the appearance of the face was as striking as the improvement in attitude. The exact treatment in any given case must depend upon the location of the disease and



acuteness of symptoms. If the process is very acute recumbency is by far the best treatment until these symptoms have subsided, and at times, especially with children, it is necessary and justifiable to have the period of recumbency extend over many months. With adults, however, bed treatment is borne less well and the patient should be gotten up and out of doors as soon as possible.

In order to make the spine immobile during recumbency a gas-pipe frame (Figure 41), devised originally by Dr. E. H. Bradford, is the most practical. A modification of this has been devised by (Figures 42 and 43) Dr. R. H. Whitman by which greater hyperextension may be obtained. On this the child is laid, with pads placed on either side of the knuckle in order to relieve pressure upon the spinous processes and to aid in a measure hyperextension of the spine. To prevent motion, straps across the shoulders and a towel pinned about the hips and legs make the apparatus complete. On such a frame the patient, if a child, can be carried about both indoors and out with practically no danger of aggravating the disease.



FIG. 41. This cut shows the frame in constant use at most children's hospitals. It is made of gas pipe, the size of which varies with the weight of the patient. It is covered with two slips made of heavy drilling or canvas which laces tightly. The separation between the two pieces occurs at the buttocks. The frame should be the width of the shoulders and two inches longer than the patient. The shoulder straps and the pelvic girdle are indicated.

With adults it is rarely possible to keep one position all of the time, so that while theoretically it is desirable, it is nevertheless necessary to be able to make a change from time to time. As long however as the patient does not sit up and the change in position consists in being rolled from side to side, improvement is not seriously inter-



FIGS. 42 and 43. This frame is narrower than that shown in Fig. 41, and is bent to suit the individual case, enabling greater hyperextension of the spine. It is in extensive use at the Sea Breeze Hospital at Coney Island. Note the different degree of hyperextension shown in each frame.

fered with. In view of the demonstrated preventability of kyphosis in many cases of Pott's Disease treated by recumbency it is most desirable to insist upon that method of treatment in children at least during the entire period when destructive changes are taking place.

When the acute symptoms of pain, muscular contraction, temperature, and night cries have passed, constant recumbency may be dispensed with and the patient permitted to be up wearing a form of apparatus designed to accomplish fixation and hyperextension.

Two general forms of apparatus are in use, — namely, metal

braces, all of which exert chiefly antero-posterior support, and corsets or jackets made of stiff material which encircle the body, giving lateral as well as antero-posterior support. Whichever is used, the aim should be not only to fix the spine, but also to hold the body in a position of hyperextension.

The form of apparatus to be decided upon depends largely upon the location of the disease, and the individual equation of the physician. No one brace or piece of apparatus is inferior to another provided the principles advocated at the beginning of this section are incorporated in it and can be carried out in the particular case. That which has yielded the best results in the hands of the writers is as follows.

With disease in either of the three upper cervical vertebræ, the patient should not be allowed up until convalescence is well advanced, and when this time is reached the apparatus employed must support the weight of the head. Recumbency with head traction

should be enjoined in such cases. If the patient is allowed to be up, with disease in this region during the acute stage the support of the head is so seriously interfered with that not infrequently the softened



FIG. 44. This shows a Thomas collar applied. This is made by cutting out a paper pattern, from which a piece of mill board is shaped, and after being wet and moulded is allowed to dry and then covered with cotton wound tightly with a gauze bandage. Oakum may be covered in this way with a bandage.

vertebræ are crushed and the upper part of the spinal cord is pressed upon, resulting at times in sudden death. When it is considered safe for a patient with disease in this region to go about, it is not necessary to immobilize the whole spine. The neck must be steadied and the head must be supported, but the support can be obtained from the shoulders and it is not necessary to carry it down to the hips, as is the case when the disease is below this point. To accomplish this

simple and efficient appliances are pictured in Figure 44, the so-called Thomas collar, and the brace devised by one of the authors. (Figure 45.)

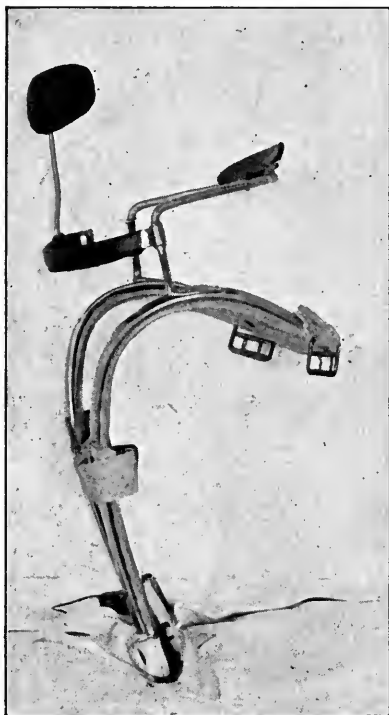
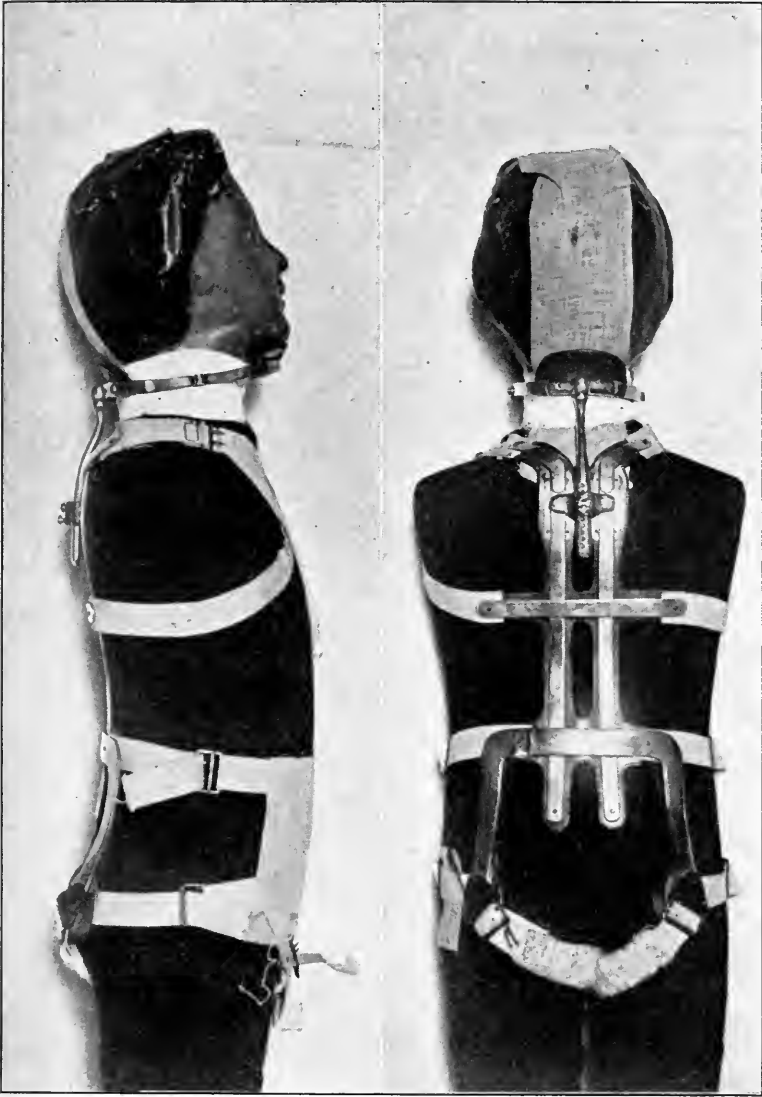


FIG. 45. Brace for cervical caries. It is made of a non-tempered steel and fitted accurately to the individual case.

With disease in the four lower cervical vertebræ or in the upper one or two dorsal, the head must also be supported, but the support must be obtained from the lower part of the body, since if thrown upon the shoulders, there is little or no tendency to decrease the pressure upon the diseased surfaces. To accomplish this the form of apparatus most commonly used is the Taylor back brace (Figure 46) with head support. If properly fitted, with such a brace the weight of the head is thrown upon the crests of the iliac bones. Plaster helmets which

are continuous with a plaster jacket give the very best support to the cervical and upper dorsal spine, but are not used as much in American practice as they deserve. With disease below the cervical region, long recumbency in the early stages is not often necessary,



FIGS. 46 and 47. Taylor brace and head support. This is the prototype of all metallic spinal braces. (Children's Hospital.)

as the vertebræ are better able to support the weight. If this should not be the case and the cord is pressed upon it is well below the vital centres, so that sudden death from such pressure is not to be feared.

With disease in the third to the fifth dorsal vertebræ, the head should also be supported, and either a Taylor brace, as pictured in Figure 46, be employed, or a plaster of Paris or leather jacket applied with the spine hyperextended and with a head support attached. (Figure 47.) A jacket with head support is most commonly used by the writers. With this, the jacket can if desired be made a fixed dressing, so that under all conditions the spine is steadied,



FIGS. 48 and 49. Illustrates well-fitting plaster jackets applied for the correction of deformity in Pott's Disease and the relief of symptoms. Note the height of the jackets at the neck in front and below the anterior superior spines.

while the head support is attached only when the upright position is to be assumed.

When disease is in the sixth dorsal vertebra or below, the head support may be omitted, and a plaster of Paris, celluloid, aluminium, or leather jacket will furnish the best support. This should be applied with the spine hyperextended, and should be long enough to grip the pelvis and hold the upper part of the sternum and shoulders well back, being carefully moulded over the iliac crests, as is shown in Figures 48 and 49.

With disease in the last two lumbar vertebræ or at the lumbosacral articulation, plaster of Paris or stiffened leather jackets extending well down over the trochanters should be used. In addition to this it may be necessary to apply a belt under the jacket to steady the pelvic joints and limit free flexion of the thighs.

In order to obtain a hyperextended position for the application of jackets, various appliances have been devised. If special apparatus is not at hand an efficient method, if the disease is in the low dorsal or lumbar region, consists in causing the patient to lie face downward with the thighs supported upon one table, and



FIG. 50. Illustrates the application of a jacket in hyperextension upon the frame.

the chest and shoulders upon another, the body sagging between. In this position the jacket can be easily and efficiently applied.

The authors' method for accomplishing this more exactly is pictured in Figures 50 and 51, and a portable apparatus, which can be folded and packed in a hand-bag, is shown in Figure 52.

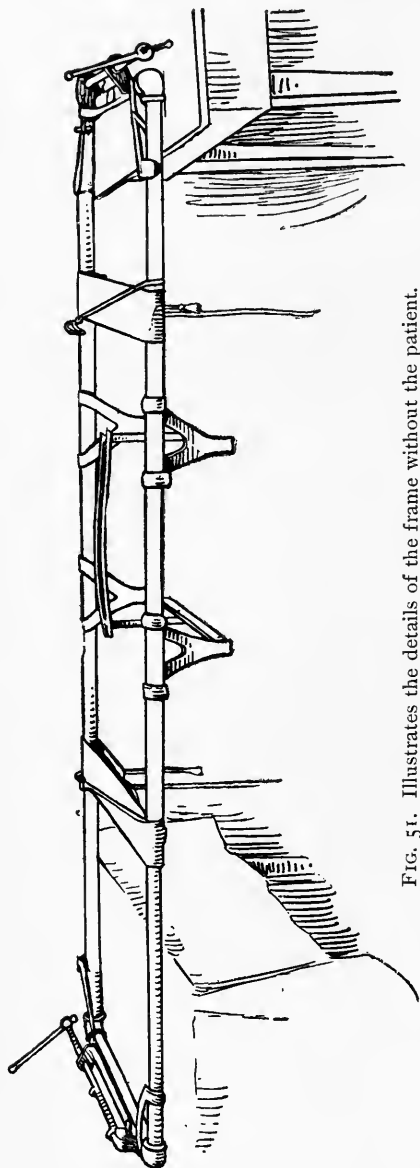


FIG. 51. Illustrates the details of the frame without the patient.

When the patient is put in the hyperextended position, as has been stated, if the disease is of recent origin the spine noticeably straightens, as is shown by tracings (Figure 53), but in a comparatively short time this actual correction disappears, due probably to the yielding of the thorax and soft parts, so that the tracing resembles the one taken before hyperextension was attempted. It should be possible, however, to prevent any increase of the deformity if these principles are consistently followed. More than this we have no right to expect when we recognize the pathology of the disease with which we have to deal. The periosteum and all of the bone-forming elements may be destroyed, so that replacement of the destroyed tissue is impossible, and if



cicatrizization can be obtained without extension of the disease or increase of deformity, the result should be considered satisfactory.

The operative treatment of Pott's Disease, other than measures directed toward the relief of special symptoms, is rarely necessary and requires only passing mention. Methods of immediate forcible correction of the deformity, revived by Calôt and Chipault in France a few years ago, have been abandoned by virtually all surgeons, among whom are Calôt and Chipault themselves, because of the inability to maintain the correction after it was once secured and

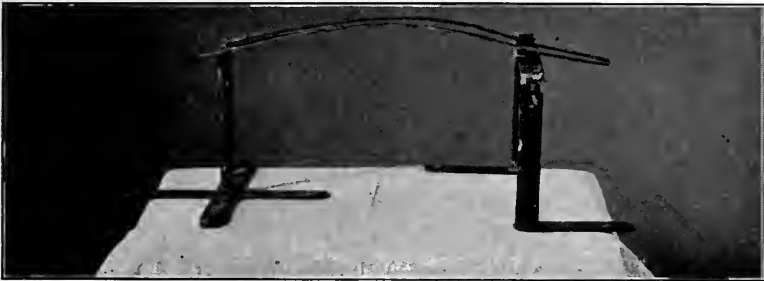


FIG. 52. Portable frame for use in applying plaster jackets.

because of the catastrophes which all too frequently followed rupture of an unrecognized pre-vertebral cold abscess. The failure of permanency in the results should have been expected from what was then known of the pathology of bone tuberculosis. Tuberculous bone lesions are not healed by being filled in with new bone.

Apophyseal ligation, or wiring together the spinous processes after attempts to correct by forcible extension, has been referred to. Numerous attempts have been made to excise local vertebral foci. In the last dorsal and upper lumbar region it has been successfully accomplished by the extra-peritoneal route. In the rib-bearing vertebræ it is of course more difficult and requires resection of ribs and endangers the pleura from perforation and infection.

In cases of paraplegia the sensory nerves become involved occasionally and great pain is caused. Division of the posterior nerve roots in the region of the kyphos is advised in such cases and has

been performed by the authors on one occasion with considerable amelioration of the patient's sufferings.

For the special conditions which develop during the course of the disease, treatment is as follows.

**Abscesses.** The management of the abscesses occurring in connection with tuberculosis of the spine should follow the suggestion and principles stated in the previous chapter. Conservatism should



The two tracings show the effect of the immediate correction of a tuberculous kyphos. (*a*) This was made before correction. Observe the greater angularity of the spine and the flatness of the lumbar curve. (*b*) Note that the kyphos has not been wholly obliterated but that the lumbar curve has been considerably exaggerated and the shoulders have been thrown back.

FIG. 53. Zinc tracings to illustrate the immediate reduction of deformity in acute cases of Pott's Disease.

be the rule, but if, because of size or location, drainage becomes necessary, it should be undertaken with the idea of avoiding an open wound or a long-continued sinus through which secondary infection could take place. Abscesses pressing on the posterior wall of the pharynx or in the posterior mediastinum, by compressing the pharynx, the trachea, the bronchi or large nerve trunks, interfere with swallowing and breathing and render immediate operation necessary. The writers have personally known of several cases of sudden death resulting from abscess in the posterior mediastinum,

causing pressure upon the pneumo-gastric nerve. On one occasion being present at the critical time and performing an emergency operation, the life of a child was saved.

The posterior pharyngeal abscess can be reached by going in through the side of the neck or through the mouth. The first is the more serious procedure, but because of the greater possibility of keeping the wound clean and preventing secondary infections, it is to be preferred wherever possible. The side on which the incision is to be made is usually determined by the fact that almost invariably the abscess is more prominent upon one side than the other. This is shown by palpation of the neck and the posterior wall of the pharynx, the incision being made upon the side of greatest prominence.

The posterior mediastinal abscess, unless it has already broken through between the ribs or found an outlet elsewhere, is to be reached by a costo-transversectomy. In this the incision is made over the ribs close to the transverse processes and just below the apex of the knuckle; a portion of one or two ribs is excised, and the pleura pushed away so that the spine can be explored. If the sac of the abscess can be definitely determined it should be punctured and a wick inserted. If however the sac cannot at once be recognized, a puncture of the vertebral body at the seat of disease should be made and this dilated, in the hope that drainage will be established through this. Such an operation is practically always performed as a life-saving measure, and speed is of the utmost importance. Not only is there little time for careful examination of the tissues, but even if this is possible the similarity in the "feel" of an abscess sac and the great veins must frequently cause uncertainty. The one successful case which was operated upon by the writers was practically moribund, having suddenly stopped breathing from pressure upon the great nerves or vessels. In the rapid operation which was performed it was impossible to differentiate the vena cava from the abscess sac, so that puncture of the diseased area in the spine, as described above, was performed, with the rapid recovery of the child as soon as the abscess was drained. In this case the incision

was made upon the right side. At another time the left side would be chosen, as the differentiation between the aorta and the abscess would probably be easier than between the vein and abscess.

For the psoas or dorsal abscess, aspiration should always be tried in case drainage becomes necessary, the puncture being made at the point through healthy tissue a little distance away from the point of greatest prominence. As much of the pus should be removed as is possible, this process to be repeated at intervals as the cavity refills.

In case an open wound becomes necessary, it should be made as small as possible and should be aseptically treated in order to lessen the danger of septic infection and absorption.

**Paralysis.** When paralysis develops the spine should be thoroughly hyperextended and the patient put to bed, because no matter how perfectly the apparatus may be fitted, it is impossible if the patient is allowed to be up, to take the weight sufficiently off the diseased area.

At times the paralysis is relieved as soon as the spine is thoroughly hyperextended, and if this be the case, a few weeks in bed with the spine in this position is sufficient, the same hyperextended position being carefully maintained, however, when the patient is out of bed. In a large number of cases the paralysis is not relieved so easily, so that a long period of bed treatment, from a few months to one or two years, is necessary. During that time the erect position should not be assumed, and the horizontal or hyperextended position should be maintained continuously.

The duration of paralysis will depend naturally upon the severity of the process and to some extent upon the situation of the disease. In the mild cases it may last but a few months, while in the severe cases the cord may be damaged to such a degree that recovery is impossible. Between these extremes are all degrees.

Just how long after the paralysis has developed treatment can be instituted with the hope of improvement is somewhat problematical. It was formerly considered that if the paralysis had existed for two years, degenerative changes in the cord would have taken place

which would make improvement impossible. In one case however which has been reported by one of the writers,<sup>1</sup> treatment was begun four years after the paralysis had become complete and was followed by enough improvement for the patient, who previously had absolutely no use of the lower half of the body, to be able to get about somewhat with the aid of crutches. The recovery was not complete, but there was enough improvement to be suggestive of what may be occasionally accomplished in such conditions.

Usually however if treatment can be started within a short time after the onset of the paralysis, recovery is practically complete, and even in those cases in which the paralysis has been so extensive that the joints have become very lax, this has been entirely overcome with the return of function. It should be remembered however that in many cases in which paralysis has been present the reflexes never become normal, and although function may be practically perfect, the reflexes remain exaggerated.

Occasionally in spite of all conservative measures, paralysis persists. In such a case laminectomy should be performed and the spinal canal explored, in the hope of in this way relieving pressure upon the cord. At times the pressure is due to abscesses which are confined within the canal, or to a tubercular meningitis, the thickening and cicatrization of which might cause the paralysis. If either of these conditions is found it is most hopeful, as drainage of the abscess or removal of the cicatricial tissue will be followed by improvement. It must be remembered however that such favorable conditions are not often found, the paralysis being due to degenerative changes or sclerosis within the cord itself, and while such operations are justifiable because of the certainty of lack of improvement without operation, we must be prepared to expect failure in the large proportion of the cases thus operated upon.

**Intercostal Neuralgia.** At times the ribs are so crowded together because of the shortening of the trunk that the intercostal nerves are pressed upon, which gives rise to much suffering. Pain due to this cause is present only when the patient stands; recumbency in

<sup>1</sup> *Transactions of the American Orthopedic Association*, vol. xiii, p. 42.

hyperextension entirely relieves it. This can frequently be lessened by a belt worn tightly around the body, crowding the lower ribs in, so that the pressure upon the nerve is avoided. If the belt fails to accomplish its purpose, a brace holding the shoulders backward and upward, by raising the ribs slightly, may afford relief. In other cases these simpler measures having failed, the removal of one or more ribs from the angle forward may be necessary. This gives more room for the remaining ribs and pressure upon the nerve is relieved.

**Convalescent treatment.** When sufficient time has elapsed, usually about two years after the symptoms of active disease have disappeared, discontinuance of treatment may be considered. It is well not to omit support entirely at first, because of the local and general weakness resulting from the disease and the long disuse of the muscles of the back. The jacket or brace may be omitted for a short period once or twice a day, or a less rigid appliance may be substituted. The brace pictured in Fig. 45 is the support most commonly used by the writers during the convalescent period. At first it should be worn all the time when the patient is about, but as the strength returns it can be gradually omitted.

In case the disease should become active again, as is sometimes the case in spite of the greatest care, the treatment is similar to that employed in the original attack.

### ILLUSTRATIVE CASES

**Case I.** The following report is cited to illustrate a small but still very important variety of cases which are caused by a direct extension of a tuberculous focus in the mesenteric glands to the front of the vertebral column.

The patient was a male of thirty years, a farmer by occupation, residing in Nova Scotia. He entered one of the surgical clinics because of pain in his lumbar region, radiating down the legs. His general health was good. There was no antero-posterior deformity. The spinal motions were restricted in all directions, and a diagnosis

of osteo-arthritis of the spine was made and a leather jacket fitted. The patient returned to his native place wearing the jacket and was considerably relieved by its support. One year later he returned because of a large swelling in the right thigh and because he was failing in general health. There was no antero-posterior deformity of the spine. Spinal motions were all guarded. A very large, fluctuating swelling occupied the upper, inner, and anterior aspect of the right thigh. This swelling was connected with a fluctuating mass in the right iliac region and also in the right loin. This abscess was aspirated and a very large amount of thin pus was evacuated. About four days after the aspiration symptoms of intestinal obstruction developed and the patient died four days later. An autopsy showed an extensive tuberculous adenitis of the retroperitoneal glands, some of which were suppurating and others of which were caseous. This collection of glands was matted together with the small intestine, and a part of the mass of glands was adherent to the second and third lumbar vertebræ, which were deeply eroded and suppurating.

**Case II.** As an illustration of a tuberculous process in the vertebræ which does not cause a kyphosis, the following case is cited. Mr. B., aet. 24 years, came under observation because of pain in the low dorsal region. All motions of the spine were restricted and accompanied by pain. After several months a swelling appeared in the right iliac fossa, and coincident with this a list of the trunk toward the right was noticed. This swelling soon fluctuated and was opened under ether and a considerable amount of thick, creamy pus was evacuated. Some of this was inoculated into the abdomen of a guinea pig. Typical tubercular lesions developed in the pig in the course of six weeks. The abscess healed in about six months; jacket and brace were worn for over two years, the symptoms gradually disappeared and the patient has been perfectly well for four years and has given up entirely the use of apparatus. He plays handball, weighs 210 pounds, and is in perfect health. There is no antero-posterior deformity and practically no limitation in motion

to the right, and only a slight restriction toward the left. A radiograph (Figure 35, p. 79) showed a definite focus on the lateral aspect of the second lumbar vertebra.

A case somewhat similar to this, so far as the location of the focus by the X-ray was concerned, has been under observation.<sup>1</sup> A psoas abscess has developed. There is no antero-posterior deformity, but instead of that there is an extreme lumbar lordosis which has increased as the case has progressed. There is also some lateral deviation of the trunk.

**Case III.** In the thoracic region the writers have seen a case of tuberculous abscess discharging through a bronchus and being expelled through the mouth. The patient was a small boy with a very marked kyphos in the upper dorsal region. The child's mother said that when the abscess first broke there was an enormous discharge of pus through the mouth. Phthisical foci in the lung extend to the pleura and there become adherent to the anterior surface of the vertebral bodies and tuberculous foci in the bodies of the thoracic vertebræ may be caused in this manner just as tuberculous foci in the abdominal glands may extend to the low dorsal and lumbar vertebræ. In the same way, though in a reverse order, tuberculous osseous foci may develop soft-part lesions in the posterior mediastinum and later in the lung.

**Case IV.** The following case of paraplegia was under the observation of the authors for three years, and the autopsy and special report of the cord lesions have been fully reported in "The Boston Medical and Surgical Journal," vol. CLI, no. 22, by Dr. E. W. Taylor and from this article we quote extensively because the case represents an instance of the most intractable form of paraplegia and because the various causes of this complication of tuberculosis of the vertebral column is here admirably discussed.

"P. McG., forty-five years old; Irish; a teamster; was admitted to the Long Island Hospital, April 16, 1895. He had been in the

<sup>1</sup> Vide Case I, p. 100.



Boston City Hospital the preceding summer with typhoid fever. About two weeks after his discharge he noticed a lump about the middle of his back, which was not painful. Shortly after this he had difficulty in walking, and was then treated at the Carney Hospital. Under this treatment the lump decreased considerably in size.

"The history given at the Long Island Hospital was as follows: He denied venereal infection, and in general had been well antecedent to the attack of typhoid fever mentioned. He had remained in bed twelve weeks, and for three weeks had been treated with a plaster jacket, after which he was able to do his work. About two months before admission to the Long Island Hospital he had noticed weakness of the legs, although he was still able to walk. At the time of entrance he was unable to walk and complained of numbness of the legs and cold sensations in the legs from the knees down. He also had some difficulty in micturition, but no incontinence. There was at no time any cerebral disturbance.

"*Physical examination* at this time showed the arms uninvolved; passive movement in both hips slightly hindered; stiffness and rigidity of both legs, particularly of the right; ankles rigid; active movement impaired in all directions; no ataxia; feet in position of marked plantar-flexion; knee jerks on both sides very much increased, with patella clonus; ankle clonus strongly indicated on both sides; plantar on both sides definite; <sup>1</sup> cremaster present, slight; abdominal and epigastric reflexes normal. Sensibility to pin prick was at this time unimpaired; contact was also normal and there was no loss of muscle sense in the toes.

"From this time on the symptoms already noted increased steadily in spite of such treatment as was applied, the kyphosis varying in size, dependent largely upon whether the patient attempted to sit up, when it at once increased. The spastic rigidity of the legs increased to practically complete paraplegia with highly exaggerated reflexes, but without marked objective disorder of sensibility. Sensations of numbness in the legs were prominent; difficulty in micturition persisted, and he had at times painful sensations in the epigastrium

<sup>1</sup> The Babinski phenomenon had not at that time been studied.

when he attempted to sit up. Contractures of the feet became very marked, and slight but definite disorders of sensibility came on in the legs; the prick of a pin could no longer be recognized as such. This condition remained fairly constant with occasional temporary improvement, but on the whole there was a steady increase in the signs of injury to the cord. On July 20, 1898, he was discharged to the Carney Hospital. During his stay there he improved decidedly in spite of the development of a genito-urinary tuberculosis. Dr. Goldthwait has kindly written me as follows:

“He was seen by me about nine years ago, first at the Carney Hospital, then being about forty-four years of age, with a sharp knuckle in the spine, undoubtedly representing a beginning Pott’s Disease. He was treated at that time but gradually developed a paraplegia, for which in those days we knew no other treatment than long quiet in bed. The principle of hyperextension, which has been used so much since, was not then instituted. Accordingly, as it meant a long period of rest he went to Long Island, and was seen by me two or three years afterwards. At that time the paralysis had existed for four years, and while there was naturally little expected of treatment by hyperextension, in the light of a few cases with marked improvement where the paralysis had existed for a shorter time, his removal to the Carney Hospital was advised. \* \* \* \* \*

“At the time of the transfer there was absolute paraplegia, except that in one foot the toe could be moved slightly, due apparently to some slight power in the short flexors. On entering the hospital the spine was hyperextended, this treatment being continued for nearly two years. During the long period of paralysis adhesions had formed in the knee, hip and ankle joints, the feet being in a position of extreme dorsal extension. These adhesions were broken under ether and tenotomy of the Tendo Achillis performed. In the first six months decided improvement took place, and voluntary contraction of practically all the muscles below the waist became possible. There was, of course, much less strength than normal, but the contraction of all the muscles was definitely apparent, and there was sufficient in the anterior thigh muscles so that horizontal extension

of the legs was possible. With the jacket it became possible for the patient to swing himself out of bed, and with the aid of crutches to hitch along the ward. The improvement made him distinctly less helpless, so that the hospital care was less arduous. During the last year of his stay at the hospital the improvement amounted to little. There was, perhaps, a slight increase in the amount of strength in the legs, but the change was almost imperceptible.'

"After staying two years at the Carney Hospital he returned to the Long Island Hospital, Feb. 29, 1900, with a decided improvement in all of his symptoms. Passive motion still remained limited in both hips and knees, more marked on the right; he was able to abduct and adduct the legs but had no flexion. He had fairly good motion in toes and plantar-flexion in both feet. The knee jerks were very active, and there was ankle clonus on both sides. Sensibility was essentially normal to pain and temperature. The back was straight, somewhat rigid, without kyphosis. A leather jacket was continually worn, but it was with great difficulty that the patient could be induced to walk or take exercises. He was able, however, to walk the length of the ward with crutches, swinging his legs somewhat from the hips, a very marked improvement over his condition before going to the Carney Hospital.

"From this time on up to Oct. 13, 1901, his condition remained fairly good apart from excessive constipation and disability resulting from the cord lesion. Oct. 31, 1901, he was seized with a sudden attack of abdominal pain, with vomiting. Examination showed tenderness over the abdomen, but without distention or spasm. He improved, and on Dec. 6, complained of nothing beyond persistent constipation. Recurrence of abdominal pain appeared with attacks of nausea, vomiting, and a gradual failure in physical condition.

"Feb. 15, 1902, the following note was made: 'Last night the patient was seized with a very severe attack of nausea and vomiting. About this time the pain in the abdomen became marked and was not benefited either by irrigation or fomentations. Patient complained of feeling very weak; pulse was rapid and weak. He was stimulated and given calomel in divided doses by mouth. He passed

a fairly comfortable night. This morning he seemed much better, took a fair amount of nourishment and retained it. His condition remained the same throughout the day with no signs of nausea, vomiting or pain until about 4.30 P. M., when he was found by the nurse to be in a state of collapse. There was marked cyanosis and dyspnœa; pulse was rapid and weak, and he complained of excruciating pain in his abdomen. Under vigorous stimulation he rallied for a few hours, but quietly died at 10.30 P. M.

"AUTOPSY. (02: 14, lxx.) By Dr. G. B. Magrath, Feb. 18, 1902. Sixty-four hours post-mortem.

"*Anatomical Diagnosis:* Chronic adhesive pleuritis; œdema of the lungs; hypostatic congestion of the lungs; amyloid infiltration of the spleen; focal necrosis of the liver; chronic nephritis; tubercular pyelonephritis; amyloid infiltration of the kidneys; dilatation of the ureters; chronic cystitis; tuberculosis of the prostate; tuberculosis of the epididymis; fistula of the urethra; tuberculosis of the spine; tuberculosis of the aortic lymph nodes.

"*Lungs:* Anterior borders meet in median line. The left in its posterior two thirds is dark bluish-red and of slightly increased consistence, upon section, very frothy on pressure. The right lung presents similar characteristics with the addition of a small puckered scar at the apex. Both lungs are fairly crepitant throughout.

"*Kidneys:* Wt. of left, 180 gm.; estimated wt. of right, 100 gm.; capsule slightly adherent. Left kidney 12 cm. in length, free surface considerably lobulated, the lobules pale brown, the depressions red; upon section, markings distinct, pyramids brown, cortex pale yellow-brown; glomeruli visible as pale points which upon the application of Iodine become mahogany-red: cortex uneven, 4-5 mm. in thickness; some of the pyramids show small, irregular, cheesy areas. Right kidney, 7.5 cm. in length; the perinephric fat about the upper lobe presents an irregular cavity about 3 cm. in diameter, containing thick, greenish-yellow pus; upon section, the apices of the pyramids present erosions, in one instance extending to the cortex, and resulting in a cavity containing a calcareous mass; the pyramids in the vicinity of the erosions are somewhat caseous; pelvis slightly

dilated, its mucous membrane in places reddened; general color gray-red; cortex 4 cm. in thickness. The right ureter is dilated, 2.5 cm. in circumference; upon section, wall 3 mm. in thickness, the inner surface smooth and red.

"*Spinal column* : At the level of the eleventh thoracic and the first to third lumbar vertebra shows some general thickening with some flattening of the anterior surface of the bodies, together with backward curvature.

#### SPINE

"The following detailed examination is limited to the spine and cord :

"Longitudinal, dorso-ventral hemisection of the spine (see Figure 54) shows several vertebral bodies invaded by the tuberculous process, and one body (eleventh thoracic) practically entirely disintegrated. Above and opposite to this body the tuberculous mass constricts the spinal canal. A similar process, but much less marked, occurs in the bodies immediately above and below this point, especially on their ventral aspects. The dorsal kyphosis is slight, due to the fact that the opposite vertebral body, although disintegrated, is not greatly deformed. The sub-dural space of

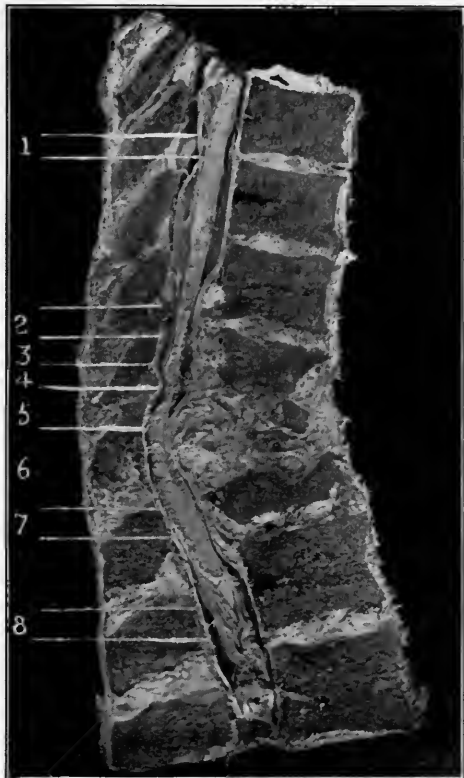


FIG. 54. Hemisection of spine from seventh thoracic to second lumbar vertebra inclusive, showing tuberculous process especially developed in the eleventh thoracic vertebra.



the cord is at no point invaded, and the damage to the cord at this level, conspicuous in the clinical side, through the course of the illness was brought about certainly in part by the effects of extra-dural pressure. Immediately above this focus of disease (Figure 55) is an annular constriction of the lumen of the canal, reducing its caliber one fourth to one third. There is absolutely no intra-dural tuberculosis here or elsewhere, but the dura is traversed by annular connective tissue bands which are apparent on its inner surface. The dura is easily separable from the bone dorsally, excepting at this point of constriction. Ventrally, the dura is closely adherent to the bone, and also laterally, but to less degree. On the ventral side, the dura and the periosteum are firmly adherent for a distance of three and a half inches or about three bodies. Above and below this point of special constriction the cord is externally normal, the lumen of the canal not being sufficiently narrowed to exert immediate pressure. The freedom of the canal from tuberculous deposits is particularly worthy of note. Further sections of the vertebral column show various foci of old, inactive tuberculosis in the bodies at the level under consideration.

FIG. 55. Cross-sections, showing areas of degeneration at the eight levels studied. (See Fig. 54.) Edinger drawing apparatus; accurate tracings. The defect in the sections, especially in 1, 2, 6, 7, is due to the fact that a preliminary hemisection of the spine with the cord in situ was made. The deformity of the cord, due to actual pressure, is shown in 4 and particularly in 5, being in sharp contrast to the well-preserved general contour of the other levels.

## MICROSCOPIC EXAMINATION, CORD.

"Sections of the cord were cut from eight levels, below, through and above the main tuberculous lesion (Figure 54). The extent of the local injury to the cord is shown by the secondary degenerations.

"At level 4 (Figures 54 and 55) there is likewise a marked deformity of the cord with dorso-ventral flattening. The histological changes are essentially the same as those of the next lower level, 5, practically a complete transverse lesion.

"A summary of the foregoing findings gives these points of special importance: Tuberculous disintegration of eleventh thoracic vertebra, and to less degree of several adjoining vertebræ; constriction of lumen of the spinal canal; no intra-dural tuberculosis; widespread degeneration and deformity of the cord at the level of the eleventh vertebra; secondary degenerations above and below this level, with marked sensory involvement.

"The following matters call for further comment: First, the effect of treatment in relation to the post-mortem findings; secondly, the method of production of the cord alterations; thirdly, the relation of the lesion to prognosis in tuberculosis of the spine in general, and the means by which mechanical treatment benefits.

"It appears from the clinical course of the case in relation to the autopsy that a process of extreme severity, leading to irremediable alterations in the cord, must have occurred early in the disease. The comparative slightness of the kyphosis at any time is no doubt in a measure explained by the late onset of the disease, at the age of forty-four. It is of interest, though it has frequently been observed before, that the degree of cord injury is not dependent upon the amount of bony deformity, but is rather due to the character which the tuberculous process assumes. In a detailed study of two cases of Pott's Disease, Spiller<sup>1</sup> alludes to the fact that only in an exceedingly small percentage of cases is the injury of the cord due

<sup>1</sup> Spiller: "A microscopical study of the spinal cord in two cases of Pott's Disease. *Bulletin, Johns Hopkins Hospital*, ix, 125. 1898.

to deviation of the vertebræ alone; in the great majority, 98% by one estimate, the paralytic symptoms are produced by an external pachymeningitis brought about by the tuberculous deposit. Inasmuch as such a deposit is usually of gradual formation and is prevented for a considerable period of time from actually encroaching upon the cord, because of the intervening dura, the tendency of paraplegic conditions towards recovery finds a ready explanation. It often enough happens that in cases which are particularly active, or in those in which treatment may not have been faithfully carried out, the dura is penetrated and the cord then becomes exposed to a direct pial inflammation and an accompanying invasion of its substance, a matter also discussed in a measure by Spiller. In such cases the hope of recovery is less and the possibility of a general tuberculous infiltration, with an acute softening of the cord, correspondingly increased.

"In the case which forms the subject of this communication, the paraplegic symptoms were well developed, though they afterwards increased somewhat, when the patient first came under observation at the Long Island Hospital. Before he was transferred to the Carney Hospital for special treatment, the condition of the legs and sphincters, exaggerated knee jerks, etc., justified the assumption that the cord was definitely involved. Laminectomy for the relief of these symptoms had been considered, but was not done. In spite of the apparently hopeless condition of the patient, the vigorous and long-continued treatment by extension, supplemented by massage, unquestionably led to a very considerable amelioration of the symptoms, during the first year of his stay at the Carney Hospital. The improvement would no doubt have been permanent and in a measure progressive had not a genito-urinary tuberculosis supervened, with a gradual, wide dissemination of the process. As it was the patient was able to be up, and to make some pretence toward unaided locomotion. The study of the condition post-mortem, to be discussed in detail, later, showed a wholly extradural tuberculous process, not very active in appearance, which early in the disease had no doubt been more acute, and had led



to sufficient pressure, aided by the kyphosis, to injure the cord and nerve roots to the extent of producing a destructive, transverse local lesion, with the later development of the secondary degenerations which have been described. It is hard, therefore, to picture a case which clinically, and as more completely studied post-mortem, could present a more hopeless prospect of benefit through treatment, however energetic.

"It is increasingly evident that the exact mechanism of the cord lesions, in Pott's Disease, varies in different cases, and it becomes a matter of importance to determine, if possible, the character of the underlying process. Schmaus and Sacki,<sup>1</sup> in a detailed article on the subject, like Spiller, insist upon the rarity of bony compression as a cause of the cord alterations and are inclined to attribute importance to œdema, produced by venous and lymph stasis, leading secondarily to glia proliferation, swelling of nerve fibres, and the elaboration of certain chemical substances, which in turn give rise to inflammation. Apart then from the mere fact of greater or less compression of the cord, a toxic cause is also at work, the result of œdema, which indirectly is due to the altered conditions of the circulation, brought about by the tuberculous process. Animal experimentation has shown that œdema quickly leads to degeneration of nerve elements and sclerosis. Other factors these writers regard as of less consequence than œdema, though the possibility of anæmia of the cord and direct transmission of inflammation by way of the pia are recognized. The term compression is naturally disapproved, the condition being rather due to the results of disordered circulation. From this point of view such improvement as takes place is regarded as due to the relief of œdema, and also possibly to the preservation, and even to the conceivable regeneration of central fibres with restoration of function. The recent experimental work of Max Borst, embodied in the last Warren Triennial Prize Essay, is important in relation to the question of the possibility of the restoration of fibres of the central nervous system.

<sup>1</sup> Schmaus-Sacki: *Vorlesungen über die pathologische Anatomie des Rückenmarks*, p. 417.

Results appear to prove that under favorable conditions a certain regeneration may take place.

"Considering the case here presented, bony compression, probably more than ordinarily met with, accounts in a measure for the pronounced cord symptoms. The deformity of the cord bears evidence to this fact. A further cause must, however, be sought for the high degree of pathological change within the cord. No doubt, vascular changes with œdema, as described by Schmaus-Sacki, were responsible although the evidence of œdema at the late stage when the cord was studied was not apparent. In the absence of extra- and intra-dural tuberculosis, no other explanation appears available, unless we admit the local action of a problematic toxin elaborated by the neighboring, at one time active, process. Alfred Gordon has recently described in detail a case in which marked changes of the cord were found, with no pressure whatever from displaced vertebræ, and quotes Homen's experiments, in which he showed that such lesions are due to toxins, elaborated by the bacteria, when the bacteria themselves are no longer demonstrable.<sup>1</sup> The fact, at least, must now be generally admitted, that actual pressure is but one element in the production of the lesions occurring in

<sup>1</sup> Gordon: *Journal of Nervous and Mental Diseases*, xxxi, 526, 1904.

In this connection a paper by Orr, "A contribution to our knowledge of the course of the lymph stream in the spinal roots and cord," *Rev. Neurol. and Psych.*, 1, 639, 1903, is suggestive. His main conclusions are as follows: 1. Although bacteria have little tendency to spread along the nerves, their toxins can be carried in the lymph stream and exert their influence some distance from their source of origin. 2. In the spinal roots the flow of lymph is upwards towards the cord. 3. Of the lymph flowing up the posterior roots, the greater part passes into the posterior columns, while a small quantity flows into the lymphatic spaces of the pia-arachnoid covering the posterior and lateral regions of the cord. 4. Where the fibres enter the cord, at which point their sheath and neurilemma are lost, they are specially vulnerable to the influence of toxins in the lymphatic system of the roots and meninges. This applies to both sensory and motor nerves. The last two conclusions are important in view of the recent opinion expressed by Marie and Guillain on the etiology of tabes, viz., that this disease is due to a lesion — probably syphilitic — of the lymphatic system constituted by the posterior roots, pia and cord. 5. The course of the lymph stream in the posterior columns is ascending. 6. The lymphatic system of the posterior columns does not communicate with that of the lateral columns.

See also Guillain: *Rev. Neurolog.*, no. 23, 1899.

Pott's Disease, and that disordered conditions of the circulation and possible toxæmia play a definite, though not as yet precisely determined part.

"A recent paper by C. L. Dana<sup>1</sup> is also of interest. Among five different ways in which tuberculosis may affect the spinal cord, Dana includes a myelitis of tuberculous origin, which he asserts is not yet recognized as a pathological entity by neuropathologists. He quotes a case, in which a man, suffering from amyotrophic lateral sclerosis, suddenly developed fever, with a rapid paraplegia, death occurring within a week. Post-mortem the cord showed an acute non-hæmorrhagic softening in the lower part of the cervical region, and in this softened area tubercle bacilli were found. Dana regards this, therefore, as a case of acute tuberculous infection, with myelitic softening. No other evidence of tuberculosis was found, but the examination was not absolutely thorough. This important case is suggestive from several points of view. It establishes the possibility of a softening (myelitis?) from the presence of tubercle bacilli alone, and possibly explains the frequent suddenness of onset of paraplegic symptoms, which gradual compression or œdema would not be sufficient to produce."

<sup>1</sup> Dana: *Med. News.*, April 9, 1904. Also, *Studies from Department of Neurology*, Cornell University, vol. 1, 1904.

## CHAPTER III

### TUBERCULOSIS OF THE HIP

TUBERCULOSIS of the hip, or hip disease, according to the customary nomenclature, ranks next to tuberculosis of the spine in frequency. The liability of this articulation to injury and its importance in the function of weight-bearing, the performance of which entails many slight traumatisms, probably determines the frequency of tuberculous disease in this situation.

In a majority of cases of this form of arthritis the process originates in the epiphysis of the head of the femur. Primacy in the acetabulum is not infrequent. Tuberculous foci in the great trochanter may extend along the neck of the femur and eventually involve the head of that bone. There is no positive proof of the primary origin of tuberculous lesions in the synovial membrane of this articulation, but there seems good reason, from analogy with other joints, to assume that it may occur. Some authors maintain that 20% of the cases are primarily synovial. The high percentage of osseous involvement may perhaps be explained by the very intimate relation in this joint between the capsule and the bone and cartilage.

Boys are rather more subject to this lesion than girls, presumably because of their greater liability to the traumatisms so frequently associated with the development of tuberculous lesions. Double hip disease is rare as compared with the unilateral form, but is not very infrequent. Tuberculous disease in the hip is occasionally associated with like lesions in other joints. The first decade is the period of life when the greatest number of cases occur. Adolescence and young adult life however claim a good many victims. Relapses of old, apparently healed processes are more frequent in tuberculous arthritis of the hip than in any of the other joints. One reason for this would seem to be the fact that few cases of tuberculous disease

recover without more or less deformity. Use of a limb deformed by this disease may be associated with great strain to the articulation; if ankylosis is only partial and deformity exists, this strain is all the greater. It is in this class of cases that late exacerbations are most frequent.

## SURGICAL PATHOLOGY

Considerable surgical interest should attach to the pathology of hip disease, since a certain number of these cases require operative interference. A knowledge of the gross pathology of tuberculosis is of great importance to the surgeon who has to meet these conditions. The hip joint is not so constructed that inspection of its various surfaces can be readily made. The acetabulum cannot be inspected through any incision while the head of the femur is allowed to remain in its socket. The extent of any given process in the hip joint therefore cannot be accurately determined through an exploratory incision. Knowledge of the types of destructive changes of which one may obtain some inkling on opening a hip joint may be of service in determining the nature of surgical treatment.

As a general rule where the process is of such severity as to lead to exploratory incision the capsule is considerably thickened, the surface of the synovial membrane is grayish in color and seems œdematous, and it is often more or less closely studded with miliary tubercles. There may be a small amount of thin or cheesy pus. Under the influence of the anæsthetic it is usually possible to obtain a good deal of motion in the joint, though this may have been entirely absent before anæsthetization. By rotating the head of the femur it is possible to expose the greater part of the periphery of that portion of the bone which is protected by cartilage. Localized erosions may in this way be detected. A considerable portion of the articular surface of the femoral head cannot however be exposed in this way. These localized (Figure 56) erosions usually mark the location of a focus in the epiphysis beneath, but such foci can rarely be locally extirpated. Occasionally however an epiphyseal focus works back

toward the diaphyseal line and comes to the surface just outside the cartilaginous covering of the head of the femur. In doing this a pannus is generally formed which overlaps the margins of the cartilage, erodes it, and sometimes lifts it entirely away from the sur-



FIG. 56. Illustrates the localization of a tuberculous focus close to the margin of the trochlear surface of the femur; the erosion of bone and cartilage is plainly visible. Observe also the atrophy of structure in the neck and trochanter. The disease had been recognized two months at the time this skiagram was taken. (Loaned by Dr. A. W. George.)

face of the bone beneath. This separation of bone and cartilage is also noted when the acetabulum has been involved and the tuberculous infection has apparently traveled in one way or the other across the cotyloid ligament as a bridge. In the more advanced cases deep erosions may have taken place in the head and neck of the femur (Figure 57), in some cases causing a complete separation of the

head, leaving this portion of that bone lying loose in the cavity of the joint. In these cases there may be much osteoporosis and direct extension of the process along the neck of the femur. Necrosis of the acetabulum (Figure 58) may occur, the head of the femur



FIG. 57. Illustrates a tuberculous focus in the acetabulum and head of femur and atrophy in both size and structure.

eroding its way through or part way through to the pelvic side of the joint.

A very marked instance of extension from a primarily trochanteric process along the neck of the femur to the head of this bone and from there to the acetabulum has been discussed in the chapter on

the Operative Treatment of Tuberculous Lesions (Case v). Occasionally from foci in the neck or trochanter the process may extend down the shaft of the femur causing appearances not unlike a non-tuberculous osteomyelitis. It should be remarked, while considering the pathology of tuberculous lesions in the hip, that whereas the vast majority of such foci are primary in the epiphyses, justifying the common opinion that tuberculosis is essentially a disease of the epiphysis, there are instances where such lesions are diaphyseal and may extend quite well into the region where osteomyelitis occurs most frequently. There is therefore a possibility for a pathological confusion between osteomyelitis and tuberculosis, as well as a clinical ground for such confusion. As an instance of this, Case IV, Section I, page 102, is cited. (Figure 59.) Atrophy of bone, both of size and of structure, is seen in the femur and even in the acetabulum when tuberculous lesions have occurred on that side of the hip joint. This is noticed quite early in the course of the disease and is chiefly appreciable through a study of the radiograph. Growth of the limb is to some extent inhibited. Rapid erosion of the head of the femur or of the acetabulum may cause the femur to dislocate upon the dorsum of the ilium. A combination of erosion and osteoporotic rarefaction of the acetabulum often results in a lengthening and broadening of this cavity, while at the same time it is made shallow. Under these circumstances it may have a shape not unlike the inner surface of an oyster shell, and to this condition has been applied the term "wandering" acetabulum. (Figure 60.)

### SYMPTOMS

The clinical evidences of tuberculous disease in the hip joint are readily understood in the light of the knowledge of its surgical pathology. The symptoms seldom declare themselves suddenly or in rapid succession. There is no prescribed order in which they habitually make themselves evident, though either pain or limp is the earliest sign noted. Deformity, shortening, abscess, and constitutional disturbance are usually later in their appearance.





FIG. 58. Note the narrowing of the neck as it approaches the femoral head, the "mushrooming" of the head, the thickening and spiculation about the superior lip of the acetabulum.

**Limp.** This feature of hip disease is invariably present, even in cases which are confined in the beginning to the trochanter or the acetabulum. Sensitiveness to pressure upon congested or eroded surfaces and involuntary muscular guarding of such sensitive areas accounts for this symptom in the early acute cases. Later on when

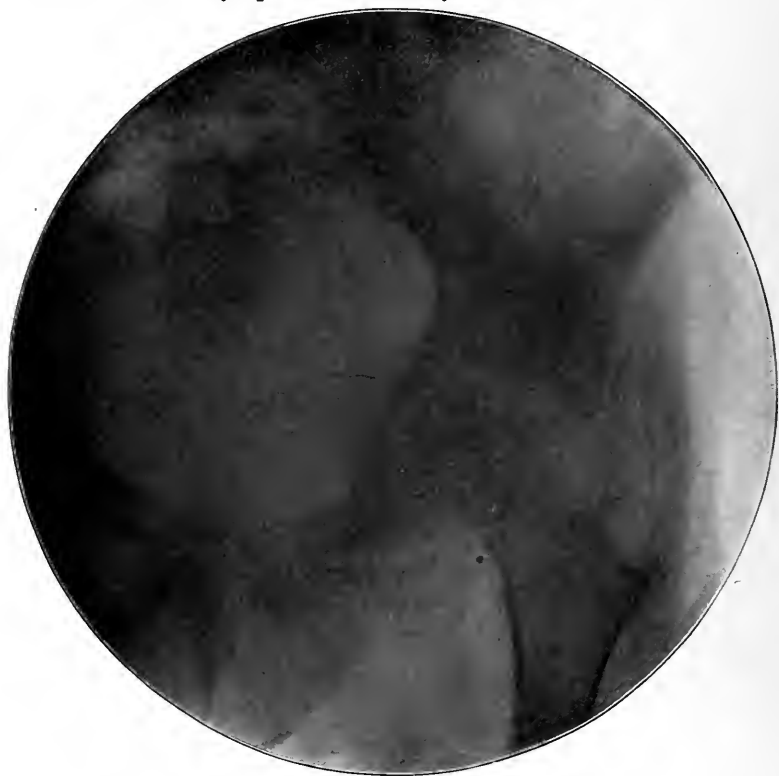


FIG. 59. Illustrates a focus in the neck of the femur which subsequently extended down the shaft giving rise to an appearance not unlike osteomyelitis; pus from this case killed a guinea pig and the autopsy showed tuberculous lesions in the pig.

destructive changes have occurred, deformity and shortening contribute their share to the production of lameness. When ankylosis takes place there is still another reason for a limp. A hip limp is quite characteristic but it does not bear any very close relation to the degree of progress of the disease. It is very likely to be characterized by intermissions, particularly in children. These intermissions do

not generally last long, and it is usually only a few days or at most weeks before it becomes a fixed symptom. Occasionally cases are met where freedom from limp has extended over months.

**Pain.** This is a fairly early and constant symptom. In a majority of instances in children it is referred to the knee joint and is commonly much more severe at night than in the daytime. As is often the case with a limp, pain may be intermittent. It is probably



FIG. 60. Illustrates the so-called "wandering" acetabulum. Observe also the atrophy of size and structure in the affected limb, a condition which has persisted in this case even after the disease is entirely cured, as is here shown.

caused by erosions on the surface of the cartilage of the acetabulum or the head of the femur, or by increase of the interarticular pressure because of the accumulation of an excess of fluid, either serous or purulent. Involuntary, because reflex, muscular contracture causes the eroded and tender surfaces to be compressed and this produces pain. During the day a patient is often able, except when jolted, to protect his diseased joint, but at night no voluntary control is possible and sudden severe seizures of pain

are quite common, particularly in children. In those cases where increase in the interarticular pressure causes pain the latter is generally lessened by relief of this tension, brought about spontaneously or with intent. The cessation or diminution of pain is sometimes the result of the bursting of an abscess within the joint, and under these circumstances is generally quite sudden. As before stated the pain of hip disease is most often referred to the knee; occasionally directly to the joint.

**Deformity.** The deformities which occur at the hip as a result of tuberculous disease are caused by muscular contracture or actual bony destruction. In the early stages of the process muscular spasm gives rise to the deformity. Later on loss of substance in the bones which make up the joint, combined with muscular contraction, prolonged faulty position, and interference with growth are responsible for deformity. If shortening be regarded as one of the deformities of hip disease it characterizes the earlier stages and progresses with the process. It may be the result of destruction of the head of the femur or of the floor of the acetabular cavity and arrested growth. Flexion of the neck of the femur, induced by activity of the disease in the neck and head of that bone, may also cause shortening. Displacement of the femoral head upward upon the dorsum of the ilium will also produce a difference in the length of the legs. In the very earliest cases where the focus is in the upper femoral epiphysis, there may be a temporary lengthening of the affected leg.

The essential deformities of hip disease are flexion, abduction, adduction and rotation, usually in this order. (Figures 61, 62, 63, and 64.) There have been many attempts to divide the progress of hip disease into stages dependent upon the deformities and symptoms which may be present. This does not afford a suitable basis for classification, as any of them, with the possible exception of abduction, may be present at any stage in the progress of the affection. There seems to be no better explanation of the deformities above referred to than the one which supposes that a focus of inflammation on the surface of the articular cartilage or near enough to the surface to be compressed or irritated by motion of the joint or weight-bear-



FIG. 61. Illustrates an extreme amount of permanent flexion in a severe case of hip joint disease. This case was ankylosed in this position. Compare with Figure 62.

ing will reflexly stimulate some one or other of the various groups of muscles which are inserted into the trochanter and neck of the femur. The muscles so attached control flexion, rotation, and adduction of the thigh principally. Such foci may be so situated or

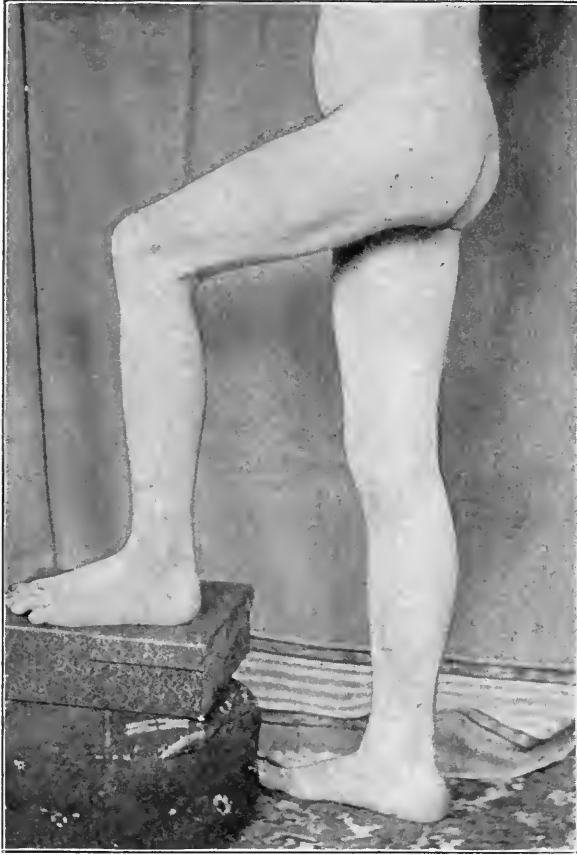


FIG. 62. The block under the foot has corrected the lumbar lordosis. This represents nearly  $90^{\circ}$  of permanent flexion.

so small that only one muscle or group of muscles is thus irritated, or it may be so extensive as to throw all the muscles having attachment to the capsule of the hip joint into spasmodic contracture. When the latter is the case there can be no motion in the joint not guarded by spasm; when the former condition obtains, there may

be quite free motion in all directions except in that which is controlled by the particular muscles in spasm. The earlier deformities should be preventable, and are correctable by preventing or over-



FIG. 63. Front view illustrating adduction, before operation. Observe the height of the anterior superior spines and the position of the left leg. There was in this case about  $25^{\circ}$  of permanent adduction.

coming, as the case may be, muscular contracture. This can be accomplished by traction or fixation. The commonest and earliest of the hip deformities is flexion. When it is of any considerable degree it interferes with function. The patient cannot place the sole

and heel of the affected leg upon the ground at the same time, unless he flexes the well leg. He cannot lie on a plane surface on the back with both legs completely and equally extended without exaggerating the lumbar curve of the spine. In order that the lumbar curve may be reduced to the normal, under these circumstances the affected thigh must be flexed to a certain degree. The amount of permanent flexion may be determined in degrees by measurements and reference to tables which can be found in orthopædic text-books.<sup>1</sup>

The practical effect of adducting the thigh is to shorten the leg; of abducting, to lengthen it. In the first case the pelvis is tilted so that the anterior superior spine on the side of the affected hip is on a higher horizontal plane than its fellow of the opposite side. The reverse is true when abduction is present. To determine, therefore, the position of the thighs with reference to the pelvis is very important in measuring the length of the legs and in ascertaining whether there is either abduction or adduction present. Abduction as a phenomenon of any but the very earliest stage of hip disease is very rare. Apparent differences in the length of the legs are due to the occurrence of one or the other of these two principal deformities, adduction or abduction, and measurements to determine the amount of this apparent shortening are made from the internal malleoli to the umbilicus, whereas measurements to determine real shortening are made from the internal malleoli to the anterior superior spines, care being exercised that these latter prominences have been brought into the same horizontal plane before measurements are made.

Adduction and flexion are almost always associated. (Figure 65.) Rotation, either outward or inward, is a common and usually an associated deformity. Secondary deformities of some importance are frequently seen. Most common is perhaps extreme lordosis of the spine caused by a permanently flexed and ankylosed femur. The attempt to equalize the length of the legs by walking with the foot in an equine position, sometimes causes a permanent plantar-flexion with contracture of the gastrocnemius muscle. Spasm of the low lumbar muscles as well as of the psoas may be occasionally

<sup>1</sup> *Orthopædic Surgery*. Bradford and Lovett, 3d ed. pp. 105.



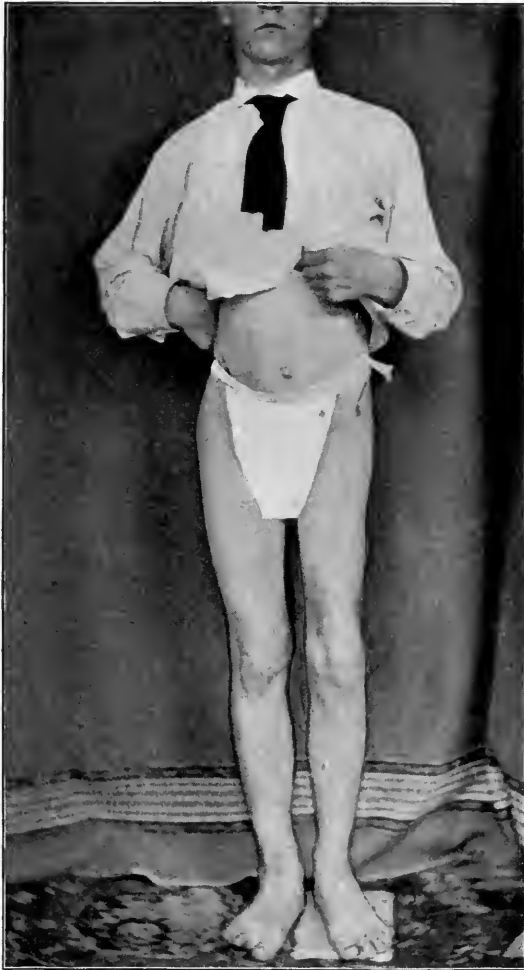


FIG. 64. Illustrates the outward rotation of the left femur. Observe that the left patella is facing outward and forward instead of directly forward as is the case with the right patella.

detected in cases of hip disease, and is a factor in producing deformity.

Varying degrees of hyperextension of the tibia (Figure 66) upon the femur are prone to occur when traction is long continued. Scoliosis is sometimes associated with shortening of one leg from tuberculous disease of the hip. The displacement of the head of the femur

(Figure 67) in the acute types of this lesion has been referred to. It is therefore only necessary to call attention to the elevation of



FIG. 65. Illustrates the association of adduction and flexion deformities. There is also a moderate amount of outward rotation.

the trochanter above the Roser-Nélaton line in cases where this dislocation has occurred.

**Atrophy.** One of the very early signs of tuberculous arthritis at the hip joint is the shrinkage (Figure 68) of the thigh and calf muscles which it produces. This diminution in size is perceptible,

palpable, and measureable, and may be very slight or considerable. A part of it is due to the irritation of an inflammatory process within the capsule of the joint because its presence in appreciable amount is not inconsistent with comparative freedom of use. The



FIG. 66. Illustrates hyperextension of the tibia upon the femur. This deformity very frequently follows ankylosis of the hip.

major part of it is unquestionably the result of impairment of function. Besides these factors tuberculous disease may have a stunting effect upon growth, at least to a slight degree, and furthermore, treatment necessarily adds an element of interference with growth by still further impairing function. Atrophy is greater in the thigh

than in the calf. It also affects the gluteal muscles, causing an obliteration of the gluteal fold on the affected side. The foot is almost invariably slightly smaller on the side where the disease is located,



FIG. 67. Illustrates the spontaneous dislocation of the head of the femur. The line drawn from the anterior superior spine across the thigh represents Nélaton's line. Note the height of the trochanter above this line. Also observe the old scars of former abscesses on the anterior and outer aspect of the left thigh.

demonstrating the interference with growth. Besides the atrophy of soft parts there is an atrophy of size and an atrophy of structure notable in the bone when studied with the radiogram.

**Muscular spasm and limitation in motion.** Spasm of the muscles about the hip is constantly noted in tuberculous inflammation of the

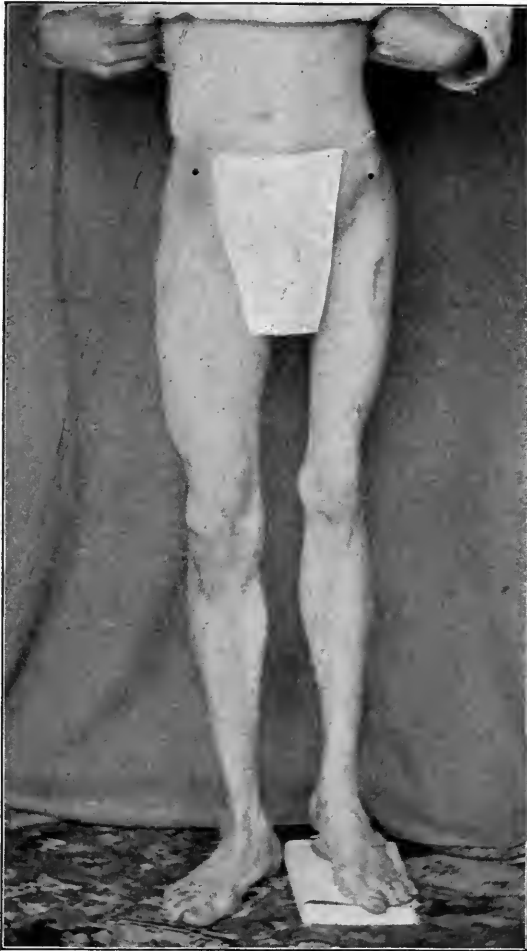


FIG. 68. Illustrates the shrinkage of the muscles of the thigh and calf in a case of hip disease. Observe also the scars of abscesses which have pointed on the anterior surface of this thigh. Note the shortening of the leg which is being corrected by a book.

hip joint. To a considerable extent it explains the restriction of motion at this joint, at least in the earlier stages of the disease. This spasm is recognized when one attempts to move the head of the

femur through its normal arcs of motion. Such attempts are resisted by a spasmodic muscular contracture which may be seen as well as felt in the case of such superficial muscles, as the adductors. The exhibition of this spasm in isolated groups of muscles and its explanation has been referred to in a previous section. Fixation of the hip joint is not always the result of muscular spasm, but may be caused by fibrous ankylosis, and it also may be produced by malpositions of the femur, as, e. g., when the head of the bone becomes dorsally dislocated. Under such circumstances abduction must necessarily be impaired, even though there be no spasm or ankylosis. Spasm of the thigh muscles is perhaps most delicately appreciated when the patient lies upon the abdomen and the observer attempts to hyperextend the thighs. At times the affected femur cannot be moved without lifting the entire pelvis.

**Swelling.** It is desirable to devote a little consideration to this symptom and its significance. It may indicate tuberculous thickening of the capsular tissue about the joint or it may indicate the presence of an abscess. It is usually noted in the former case over the anterior surface of the joint, and is frequently accompanied by an enlargement of the superficial veins. On palpation it is not difficult to appreciate an induration of the tissue underlying the skin. The fossæ immediately in front of and behind the greater trochanter are also occasionally the seat of swelling, and when this is not evident on inspection, it is often possible to appreciate it by palpation. When the disease has involved the acetabulum it often causes a swelling just below the crest of the ilium on the pelvic side of that bone. This is detected by comparative palpation of the two sides. It may also be perceived by rectal examination. The glands on the pelvic side of Poupart's ligament are occasionally secondarily swollen. The abscesses which originate in the hip joint may cause swellings in the region of the groin, the outer (Figure 69) aspect of the thigh well down toward the knee, or on the anterior (vide Figure 68) or inner aspect of the thigh from the lower third of the femur to the perineum. Rarely abscesses from the hip perforate (vide Figure 58) the acetabulum and are discharged through the



FIG. 69. Illustrates the location of old hip abscesses on the outer side of the thigh and on the buttock. Note also the great shortening which occurs in some cases of tuberculous arthritis of the hip. This was in part due to dislocation of the femoral head in this case.

wall of the rectum, and more rarely still through the bladder. A slight increase in the surface temperature is usually noticeable over these abscesses.

**General condition.** The general health of patients in the early stages of tuberculous disease of the hip is affected in no appreciable manner in many instances. In other cases one finds on careful inquiry that constitutional resistance had been low for some time before any local signs were noticed. An habitual slight rise of the evening temperature is quite characteristic of even the mildest types of this arthritis. High temperatures may be noted even in cases where there is no detectable sign of abscess. One should be on guard in such cases for evidences of general miliary involvement or the development of abscesses and mixed infections. Anæmia is often suggested by the pallor of the skin, when the determination of hæmoglobin does not indicate its presence. Malaise, loss of appetite and sleep, loss of strength, and the ease with which fatigue is produced, a lack of ambition to participate in normal or habitual exercises or pursuits, often mark the earliest phases of this trouble both in the child and the adult. Later in the course of the process, particularly in cases accompanied by abscess formation, there is often evidence of amyloid changes in the kidney, supra-renals, liver, and spleen. Bronzing of the skin, enlargement of the spleen and liver, and urinary disturbances, are most suggestive indications of this condition. Progressive loss of flesh, cough, expectoration, hectic appearance, and irregular high temperature, indicate the extension or dissemination of the tuberculous process from the hip or some other primary focus. Diarrhœal symptoms, abdominal distention, and peritoneal nodules palpable through the abdominal wall, are often noted in these cases when the infection has extended beyond the confines of the hip joint and become a generalized process. In still other cases meningeal signs indicate that focalization of the bacilli in the meninges has occurred.

There is no essential difference in the manifestations of this lesion in children and adults except that the adult life not infrequently brings a relapsing disease under the guise of a fresh infection. Pain



and lameness assume incapacitating proportions earlier in an adult than they do in a child. Abscess, if not more frequent, is more serious because of the greater likelihood of secondary infection and its attendant dangers. Extension to other parts of the body, where the consequences of this disease are more serious than they are in the hip joint, is a little more frequent relatively than it is in children. Difficulties in the way of management of grown persons are obvious, and these constitute real and serious obstacles to recovery, but aside from such difficulties there would seem to be no inherent reason why tuberculous lesions in the adult hip should not recover as do the same processes in children. Intolerance of apparatus, impatience with a chronic disabling disease, and worry over enforced idleness in the face of the necessity for activity in order to maintain one's self and those dependent upon him,— these are some of the factors that influence unfavorably the course of hip disease in the adult.

### DIFFERENTIAL DIAGNOSIS

Hip disease must be differentiated from sprains, other infectious processes, osteomyelitis, tuberculous disease in the lower spine, coxa vara, infantile paralysis, congenital dislocation of the hip, Charcot's joint; the atrophic and hypertrophic types of the chronic non-tubercular joint disease, malignant disease, bursitis, and hysterical conditions.

From **sprains** the differentiation is sometimes quite difficult. The history of a very recent severe wrench in an adult is helpful in eliminating hip disease, but many of these cases are in children from whom no definite history can be obtained. Absence of any considerable atrophy and no shortening, combined with swelling about the hip joint, together with a history of injury and immediate disability, is suggestive of a sprain. Rest in bed will quiet down an acute sprain in a few days. Acute infections of the hip joint are generally characterized by rapid onset, temperature, pain, and usually by transient lesions in other joints or evidences of some primary infection to which the hip symptoms are secondary. Such conditions are more

common in the adolescent and adult. Deformity, including dislocation of the head of the femur, may be the result of acute infections, but "real" shortening is rare. Anchylosis produced early in the course of events is the rule. **Chronic, non-tuberculous infections** are more difficult of differentiation than the acute types, but they are as a rule polyarticular, and though less sudden in their onset than the acute infections they are rather more rapid in development than the average case of hip disease.

**Juxta-epiphyseal osteomyelitis and the acute epiphysitis** of infancy are much more violent in the nature of their initial attack than is even the most severe case of tuberculous arthritis. High fever and evidence of toxæmia develop rapidly and early. Suppuration ensues and bacterial cultures, if the diagnosis is not made before these are obtainable, will clear up the diagnosis. The X-ray appearances of osteomyelitic lesions are quite characteristic. Tuberculous disease of the lumbar spine, prior to the stage of deformity, is very difficult of differentiation from hip disease. Rigidity of the low lumbar spine, with contracture of the psoas muscle and consequent flexion of the thigh, offers some difficulties to diagnosis. The fact that the psoas muscle is primarily a flexor of the thigh and to a slight extent an outward rotator, assists in clearing up the diagnosis. In cases of hip disease restriction in motion at the hip joint, where the inflammation is severe enough to cause a permanent flexion of the femur, is generally limited in all directions, not merely in flexion and inward rotation.

**Coxa vara** causes restriction in motion somewhat similar to that produced by tuberculous arthritis of the hip joint. Flexion is not restricted as much as inward rotation and abduction. Extreme flexion is accompanied by abduction, and permanent outward rotation is frequently noted. The trochanter is usually above Nélaton's line.

**Infantile paralysis** bears only a very superficial resemblance to hip disease. Atrophy and shortening may be present, but muscular spasm is absent and the history of the onset of the symptoms should commonly exclude tuberculous disease.

**Congenital dislocation** of the hip is also not associated with pain or muscle spasm, and the absence of the head of the femur from the acetabular cavity unaccompanied by any acute signs of inflammation at any stage of the trouble, together with a characteristic gait and early development of signs of congenital dislocation, should make that diagnosis easy.

**Charcot's Disease** of the hip causes limp, disability, and occasionally pain, but is almost invariably associated with the signs of tabes. The physical evidence at the hip joint is not that of an inflammatory process.

**The hypertrophic type** of chronic arthritis has an insidious onset and many features in common with hip disease. It does not declare itself until a later period of life than is usual for tuberculous arthritis, but atrophy, shortening, limp, pain, and stiffness characterize the condition when it is well established. The limitation of motion which is characteristic of this process is not caused by muscular spasm but by mechanical obstruction, and this fact is readily recognized upon physical examination. Abduction and inward rotation are most restricted.

**The atrophic type** of chronic arthritis as a monarticular process does not occur in the hip joint. There are invariably other joints involved, which renders the diagnosis much easier than in the case of some other conditions.

**Malignant disease** in or about the head of the femur may simulate hip disease in some cases. Sarcoma is the usual form of neoplasm which makes itself manifest here and this is more common in adult life than in childhood. Sarcomata of the ilium are not so very uncommon. The pain of malignant disease is more severe and uncontrollable by measures which commonly render the pain of hip disease endurable. Cachexia is more marked in neoplasm than it is in hip disease and the presence and character of the swelling of new growths is quite pathognomonic when the tumor attains any considerable size.

**Inflammations of the gluteal bursa** and of the bursa beneath the psoas and iliacus or of the one over the tuberosity of the ischium

sometimes cause confusion in diagnosis and need to be differentiated from hip disease. Restriction in motion is not usually so pronounced; atrophy and shortening are either not present or comparatively slight, whereas localized tenderness over the bursa and the early development of signs of suppuration are quite significant.

**An hysterical hip** is not an uncommon condition. It usually occurs in impressionable, neurotic girls. There is more voluntary guarding of the motions at the hip joint than there is involuntary spasm; atrophy and shortening are not conspicuous. Hyperæsthesia and other stigmata of psychoneuroses are almost always demonstrable when carefully sought.

### TREATMENT

The most successful treatment of tuberculous arthritis of the hip is that which gives recognition to the constitutional management of tuberculosis and at the same time affords well-regulated protection to the hip joint. **Constitutional treatment** in its perfection should include all the details which the most scientifically conducted sanatoria provide and insist upon. Mechanical treatment may be varied to meet conditions prevailing in the individual instance. This permits a wide latitude in devising means of fixing the hip joint and affording it proper protection, at the same time allowing the function of weight-bearing to be carried on. The tendency in this country has been to conduct local treatment with a rigor out of proportion to that devoted to constitutional upbuilding. Belief in the principle of distracting diseased surfaces as opposed to ankylosing them has very largely governed the treatment of hip disease in recent years. We have been tardy in appreciating the significance of a maximum degree of functioning capacity in joints below the level of the hip lesion. Growth, nutrition, and local resistance to invasion of tissue in and about the hip joint constitute the most important factors in the treatment of hip disease. Everything should be done to favor these conditions, consistent with giving adequate protection to the diseased joint while it is acutely inflamed.

It is not enough merely to emphasize the importance of constitutional treatment in talking with patients. A definite routine should be carefully planned and insisted upon with quite as great exactness as one insists upon the nice adjustment of apparatus. The patient and his family can be acquainted with the fact that hip disease is a form of tuberculosis without causing a panic among them. On the contrary, recognition of this fact by the family and the patient ought to be made an effective means of holding the patient up to that feature of treatment which is most efficacious.

Out-of-door life should be insisted upon during that portion of the course of the disease represented by an acute stage. If recumbency is being enforced it is a distinct advantage to have it carried on while living out of doors in a tent in the case of adults or on a frame which permits carrying the patient into the open air in the period of childhood. At night it is generally possible to have, even in the house, a much freer ingress of fresh air than is permitted in most of our dwellings. The diet should be planned so that the food ingested may be sufficient in quantity and quality to keep the patient well nourished. The scales should be consulted to determine whether weight is being gained or lost: a tendency to increase in weight is as favorable an indication here as it is in the pulmonary form of tuberculosis. Care must be observed not to overfeed to the extent of disgusting the patient with the sight of food or upsetting the digestive organs by imposing too large a task upon them or a quality of food too rich for proper assimilation. The addition of light lunches between the regular meals and before going to bed at night is a good way of supplying the extra food without the necessity for crowding too much in any one regular meal. Eggs, cream, milk, and fats obtained in the form of butter and olive oil are easily digested and help to increase weight in a very satisfactory manner.

Exercise is much interfered with by a lesion which concerns the locomotive apparatus as does hip disease. In the acute stages, when recumbency is enjoined, massage of all parts of the body except the affected hip will serve to improve the general condition by stimu-

lating circulation and improving muscular tone as well as assisting the eliminative functions of the body. As soon as local conditions will permit of exercise on the part of the patient it is desirable that as much function as is possible be permitted in all the joints except the affected one. In this way the general metabolic processes of the body are best conserved. Furthermore, use of the affected limb, provided such use is not attended by pain or other signs of acute disturbance, results in better nutrition of the entire leg, and the ultimate usefulness of that member will be greater than otherwise. Tuberculous joint cases should be surrounded by the best hygienic conditions. Good drainage, pure air in abundance, and everything that makes for good health should be utilized. In adults it is often necessary to supply much moral support and encouragement to enable a patient to make the best recovery.

The therapeutic treatment of hip disease may be divided into (a) **Drug treatment**; (b) **physical therapy**, including ambulatory and bed splints, and the treatment of (c) **abscess** and (d) **localized tuberculous lesions** in the bones composing the joint. Only such drugs are used as tend to stimulate a flagging appetite, counteract a tendency to constipation, and increase the weight. For the latter purpose cod liver oil, preferably in the form of the crude oil, is recommended. Emulsions of cod liver oil and emulsions of fats are helpful in improving nutrition.

The employment of Bier's passive congestion, though rather more difficult to carry out in the hip, has been attended with some beneficial results. Both the tourniquet and the suction cups may be employed. In our experience up to the present the use of tuberculin has been of questionable value. Mixed infections have been treated with mixed tuberculous and pyogenic vaccines without notable benefit.

The bed treatment of hip disease should be instituted whenever pain and sensitiveness are marked, an abscess is threatening, deformity developing, or the general condition becoming rapidly poor. Sensitiveness and pain may be controlled either by the application of a spica extending from the axillæ to the foot or by traction with

weight and pulley, as is shown in Figure 70. There is in children generally a certain amount of deformity which it is desirable to correct at the same time that sensitiveness is being quieted by bed treatment. In the accomplishment of this double purpose traction is rather more advantageous than fixation alone, as it enables one to overcome the deformity more rapidly. This is particularly true



FIG. 70. Shows method of applying traction in bed to a case of hip disease. There was very little permanent flexion in this case, so the leg is not much elevated and traction is being exercised in a direction parallel with the long axis of the femur. The foot of the bed is elevated to provide counter-traction. Had there been flexion to overcome, the pulley would have been raised to such a height that the pull of the extension straps would have been in a direction parallel with the long axis of the femur instead of the trunk. It is well to use a posterior plaster shell to prevent toe drop in these cases.

of children. Bed treatment in this class of patients is most conveniently carried out with the patient on a Bradford frame. Traction should always be in the line of the deformity and from four to nine pounds is all that is usually necessary to tire out muscle spasm. As soon as sensitiveness and pain has been quieted the patient may be gotten up in some form of ambulatory apparatus.

When it comes to a choice of apparatus there are two diametrically opposite principles to be considered. One principle which has been championed by the English and Continental schools places its chief

reliance on fixation in the management of these cases. The other principle is advocated most extensively by American orthopædic surgeons and contemplates a separation of the diseased surfaces by traction. Those who advocate the latter method do so because they believe that better functional results can be obtained by the employment of this principle, i. e. — more mobility in the joint and less shortening after treatment is finished. The advantages claimed for the other method are that ankylosis in a good position is the best result obtainable in tuberculous hip disease and fixation tends to produce this more readily than traction. Attention is directed to the fact that during almost the entire course of the disease a tuberculous joint is sensitive to motion but not to weight-bearing. The course of treatment is shorter and function of the affected limb may be permitted much earlier and more completely under fixative treatment than when traction is applied. Combinations of fixation and traction have been devised (Figure 71), but something of the effectiveness of both principles has to be sacrificed in the construction of a combined splint.

The authors are of the belief that fixative ambulatory methods have decided advantages over traction, the chief advantage being represented by the better control over tendencies toward deformity which the spica gives to the surgeon. The results of the application of fixative dressings in the form of the plaster spica have been attended by better results in the hands of the writers than formerly were obtained under traction treatment. This has been equally true of the mild or severe types of case. Shortening has been less; the nutrition of the limb and its muscular development have been much better. The period of the disease requiring apparatus treatment has been shortened. Deformities have been notably diminished in frequency and lessened in severity. Ankylosis has given a more stable and therefore a functionally better result in the severe cases and it has been much easier to determine the period when it is safe to omit apparatus. The trouble of fitting braces has been largely done away with, and it is the expectation of the writers that fewer relapses will follow this than followed the former methods.



The long spica (Figure 72) should be used when pain is caused by motion, and with this crutches and just enough of a high sole to enable the patient to lift the foot of the affected leg off the ground. As sensitiveness becomes less and finally disappears the spica may be cut down (Figures 73 and 74) both at the body and leg portions, thus enabling the patient to sit down and also to have free use of the leg below the knee. Crutches may still be necessary for a time, but soon some weight may be borne and eventually crutches may be discarded and the spica alone employed. No definite time for these changes can be laid down. The guide to making them is always the sensitiveness of the joint and the general condition of the patient. All such modifications of treatment should be made tentatively. We wish to call attention to the importance of position in relation to fixation treatment. In the hip there are not only flexors and extensors, but abductors and adductors, as well as rotators, so that



FIG. 71. Illustrates the application of a traction splint, which is provided with a crutch to favor abduction of the leg. The crutch presses against the tuberosity of the ischium on the well side. Child is standing on an elevation equivalent to the "lift" he should wear on his shoe. Observe also the swelling of the thigh above the thigh band, which marks the location of a hip abscess pushing out into the buttock behind the greater trochanter. (Dr. Bradford's Model.)

the balance between these groups, which is Nature's protection against deformity, is very hard to maintain. If the leg is drawn in,

the adductors have the advantage over the abductors, and the common deformity of adduction with adductor spasm is the result. If flexion begins, the extensors work at a disadvantage, and the spasm of the flexor muscles tends to constantly increase the deformity. So also is it true of the abductors and rotators.

Recognizing these facts, if a balance between these various groups of muscles can be obtained and maintained for a short time, the spasm ceases, and not only is this feature of the joint irritation removed, but the effect which this irritation has upon the reflex atrophy of the leg is also eliminated. The position in which this muscle balance is most perfectly obtained is the position in which the head of the femur rests most easily and evenly in the acetabulum, and practically consists of about  $20^{\circ}$  of flexion,  $15^{\circ}$  to  $20^{\circ}$  of abduction, and  $10^{\circ}$  of outward rotation.



FIG. 72. Illustrates the application of the long plaster spica in an abducted position for the treatment of the more acute cases of hip disease. Still more complete fixation could be secured by carrying still higher, and also including the foot.

In such a position the plaster of Paris dressing (if that be the form of apparatus decided upon) should be applied, extending from



FIGS. 73 and 74. Illustrate the short spica used in the treatment of convalescent cases of hip disease. Observe that the prominent buttock belongs to the well side, the buttock on the diseased side being well covered in by the plaster dressing, as should always be the case.

the knee to just above the crests of the ilia. The knee is purposely not included, nor is any attempt made to immobilize the lower spine, as this mobility of the adjacent joints is of importance in preserving the circulation in the affected limb, while the slight amount of motion at the hip which their use represents is of little consequence. With the early cases, in such a dressing the patients may be allowed

and should be encouraged to walk about bearing weight upon the leg. By so doing, the strength of the part is maintained, the circulation of the whole leg is stimulated, the reflex atrophy is much less, and the resistance which the part must offer to the extension of the disease is greater.

Operative treatment is undertaken in tuberculous arthritis of the hip for several reasons. Abscesses require surgical interference in many cases. The general principles elsewhere referred to are applicable here. Arthrotomy is occasionally performed to relieve pain and drain acetabular disease. The indications for the radical operative treatment of hip disease by erosion or excision have been discussed in the chapter on Operative Treatment. Where success has not attended the attempt to prevent deformity during the progress of the acute infection osteotomy is often required, both to improve appearances and function, as well as lessen the chances of an exacerbation of the disease. The technique of this procedure has also been described.

### PROGNOSIS

The outlook for the cure of hip disease in childhood is good. An indeterminate because variable period of treatment will be necessary. The time in childhood will vary from two to four years on the average. It is better to prepare the patient and parents for a certain amount of shortening and deformity. Abscesses will occur in about 30-35% of the cases but do not necessarily add materially to the gravity of the disease.

The prognosis is not quite so good in adults as in children, but is not by any means bad. The chance of extension to other parts of the body, either in the form of local metastasis or a general miliary infection, is very slight in children, and only a little greater in adults. Mixed infections and amyloid are the most serious complications of hip disease.

## CHAPTER IV

### TUBERCULOSIS OF THE KNEE JOINT. TUMOR ALBUS

TUBERCULOUS disease of the knee joint ranks third in point of frequency among tuberculous joint lesions in childhood. In the adult it is perhaps more frequent than hip disease, and about equal in frequency with tuberculosis of the spine. The knee is one of the most exposed of the articulations and is therefore subject not only to those traumatisms which are the result of weight-bearing, but also to the direct violence which not infrequently seems to pave the way for the focalization of tuberculous lesions.

Infection of the structures of this joint by the tubercle bacillus takes place through the circulation, the organisms being brought from some extra-articular focus. There are three possible osseous foci, viz. — the femoral condyles (Figures 75 and 76), the head of the tibia, and the patella. The synovial membrane (Figure 77), in the belief of the writers, is not infrequently the primary location of lesions. A contrary opinion is entertained by good observers based upon large pathological experience. The reason for entertaining the opinion here expressed is that clinical experience and the utilization of the X-ray in the examination of tuberculous knee joints seems to conclusively indicate primacy of this process in the synovial membrane in many cases. In a few patients the disease becomes arrested in this situation; in many instances it extends to the bones. Tuberculosis manifests itself many times in serous structures, as, e. g., the pleura, the peritoneum, the meninges, and tendon sheaths. It is not unnatural therefore that it should attack the synovial lining of the knee joint. Pathologic evidence to combat this supposition is necessarily obtained late in the course of the disease if obtained at operation, and even in case it is obtained post mortem, usually represents terminal lesions. The synovial type

seems to be rather more common among adult patients. The bursæ which surround the joint and communicate with it in so many instances may occasionally be the primary seat of the lesions and are sometimes secondarily invaded. Infection of both knee joints



FIG. 75. Illustrates an early erosion of the femoral condyles and a slight knock-knee deformity on the right side. Note the darker shadow on the right, indicating capsular thickening, the slightly wider separation of the tibial and femoral condyles.

rarely occurs. Occasionally the knee is involved along with other joints or other lesions of a tuberculous character in the viscera, e. g., phthisis or renal tuberculosis. The epiphyses are usually first attacked, but a tuberculous juxta-epiphyseal osteomyelitis is a possibility.

## ETIOLOGY

The fact that the majority of cases of this disease occur in childhood and during the first decade indicates that the same influences which are instrumental in producing these lesions in the hip and the spine are operative in the knee. Rapid growth, frequent trauma, intimacy of contact with possible sources of infection, the prepon-



FIG. 76. Illustrates the "squaring" of the epiphysis in the early involvement of the femoral condyles. Note that by comparison the right epiphysis is the thicker and that this would make this leg slightly longer than the left.

derance of milk as an article of food in childhood, and the likelihood of its being a carrier of infection, — any of these may be operative in tuberculosis of the knee, as elsewhere. The etiology of the adult cases is not so easily understood. A few are metastatic from other foci which may never have been noticeably active. Still others may be relapses from unrecognized lesions in childhood, but the majority doubtless are derived from glandular sources within the patient, or by direct infection from without through the medium of the circu-

lation. So far as outward signs go many instances of this lesion develop in apparently robust and healthy children and in seemingly vigorous adults.

### SURGICAL PATHOLOGY

The general pathology of tuberculosis having been considered elsewhere, it is only necessary to review the bearings of this pathology upon the surgical treatment of tuberculosis of the knee. The knee joint is a comparatively simple articulation to explore from the point of view of surgical pathology. Except for its bursal connections there are no diverticula which complicate surgical treatment. These do not always connect with the articulation. The anatomical text-books describe a pouch above the patella extending as much as a hand's breadth above this bone. This communicates with the joint in such a large percentage of the cases that it really seems a part of the articulation and not merely a bursa. This is sometimes traversed by fibrous bands which convert it into a multilocular cavity. In one instance recently under observation a tuberculous process primary in the upper half of the patella extended to this quadriceps bursa and became walled off within this closed cavity, not having extended to the knee joint at all or affected the cartilages of the femur or tibia. In this instance the opening from the joint into the quadriceps pouch had been wholly obliterated and a tuberculous abscess, which had formed in the pouch because of the caries of the patella, had been there confined.

The swelling which is so characteristic of tuberculosis of the knee is generally symmetrical on either side of the patella and extends to the top of the quadriceps pouch. It is usually due to a thickening of the synovial capsule, though there is sometimes a cold abscess present. When the capsule is incised it is found to be many times thicker than normal, of a grayish color, and has the appearance of being oedematous. It is much less vascular than most of the non-tuberculous synovial inflammations, and is not characterized by as great a tendency toward villous thickenings as is the case in the



atrophic type of chronic non-tuberculous joint disease. The serous surfaces are sometimes studded with miliary tubercles. In those parts of the joint where the synovial membrane is reflected back from the margins of the trochlear surfaces of the femur there is



FIG. 77. Illustrates quite extensive capsular disease, also a small focus on the face of the femoral condyles. There is so little evidence of epiphyseal enlargement and this osseous erosion is so superficial that this femoral lesion may readily be an extension from the synovial membrane in which the disease is very extensive. The flexion in this case may well be due to the femoral erosion.

often a pannus which overlies the cartilage and erodes it. This is one of the ways that synovial disease involves the osseous structures. The intercondylar notch, where the crucial ligaments have their insertion, is a favorite place for this extension to occur. Where an osseous focus is the primary one the epiphyseal cartilage of the femoral or tibial condyles or the central portion of the patella is the

point of attack. The femur is rather more often the first to become involved, then the tibia, and last of all the patella. The tibia may frequently become affected from an extension of primarily femoral disease. The patella itself is much less frequently eroded or diseased than are either of the other bones, even when there is quite extensive involvement of the joint. Occasionally where the focus is not in the central portion of the epiphyseal cartilage it may erode toward the diaphysis (Figure 78) and the joint capsule under such circumstances may escape involvement. More frequently, however, extension is toward the cartilage over the condyles and destruction of bone and perforation of cartilage takes place. In some cases the cartilage is not penetrated and a cavity containing the remains of a tuberculous abscess and possibly some active tuberculous granulation tissue will be found beneath the trochlear surfaces. At times where there has been perforation of the cartilage, walling-off of the local process has taken place, the neighboring trochlear surfaces remaining clear. Under such circumstances motion may be preserved in the joint to a very large extent. Such foci are always a source of danger to the individual, as they may be stirred into activity at any time. In the early stages of epiphyseal tuberculous disease the first effect of the location of such an inflammatory process in the growing centre of a bone is to stimulate its growth, and consequently the entire epiphysis becomes quite symmetrically enlarged (Figure 79), causing an **actual lengthening** of the affected leg. In most cases this goes on to destruction and some shortening may take place, though this is not usual. Inasmuch as the destruction is likely to affect one of the femoral or tibial condyles more than the other a knock knee is a more usual deformity than shortening. Combined with this there is often subluxation of the tibia. Suppuration occurs in about the same proportion of cases of tuberculous disease of the knee that it does in other localities. It may be in part absorbed and in part locally encapsulated. In some cases large-sized, lamellated, rice bodies are found in the joint. They are formed in the same manner that they are in the tendon sheaths, but are much larger. In the early stages of a synovial tuberculosis there is some-



FIG. 78. Observe the rarefaction of the bone, particularly of the femur, and the erosion of the epiphysis close on the diaphyseal line.

times an effusion in the joint, but it is occasionally difficult to determine its character. Aspiration of fluid and study of stained specimens may show the tubercle bacilli, or inoculation may be

practised for diagnosis. Cytological examination yields no evidence of positive value in this matter.



FIG. 79. Illustrates the "squaring" of the femoral epiphysis due to hypertrophy of this portion of the femur from primary epiphyseal disease. The lower portion of trochlear surface of the femur is elongated and the flexion deformity present is due to this fact. Capsular involvement is slight. (Cf. Fig. 74.)

### CLINICAL COURSE AND SYMPTOMS

The natural history of tuberculous disease in the knee joint bears very close resemblance to the same process elsewhere. Insidiousness of onset, intermittency in the severity, and even the very existence of symptoms, the chronic character of the disease, a tendency to the development of permanent deformities, and more or less complete

ankylosis marks the process. The most important evidences of its presence are the following symptoms.

**Pain.** This symptom is quite common and except for the limp is perhaps the earliest one noted. When the focus is confined to the



FIG. 80. Note the flexed position of this leg in the standing position. Limp must necessarily result from such an amount of flexion.

epiphysis it is not likely to be very severe, but when it begins to erode the cartilage it is more pronounced and may be very severe. Children make less complaint on the whole than do adults. It is usually more troublesome at night and is referred directly to the joint. It is

very amenable to fixation, thus indicating that proximity of the focus to the joint surfaces is responsible for the symptom. There is often a good deal of tenderness to pressure over the outside of the

joint and passive manipulation as well as weight-bearing aggravates the condition.

**Limp.** This is an early sign of tuberculous trouble. It may precede any permanent deformity, but is usually associated with a flexed position of the leg in weight-bearing. (Figure 80.) Under these circumstances, it represents an involuntary attempt to take pressure off a diseased focus in the weight-bearing surfaces of the joint. In synovial cases limp is caused by a reflex spasm. If the case progresses to permanent deformity the gait is necessarily impaired.

**Muscle spasm and deformity.** Reflexes from intra-articular erosion or the presence of the products of inflammation within the joint cause contracture of the hamstrings. This gives rise very early in the course of the disease to a more or less pronounced flexion at this joint. (Figure 81.) Some-



FIG. 81. The flexion shown in this case was largely due to muscular spasm and was corrected at one sitting under ether. This had occurred early in the course of the disease.

times it is scarcely recognizable as a positive flexion but only as an impossible complete extension. That it is spasmodic is demonstrated by the fact that it can be more or less entirely

overcome by fixation and rest. As the process advances and destructive changes take place in bone and cartilage flexion becomes more marked and less correctable and the presence of



FIG. 82. Illustrates a marked degree of knock knee and a moderate amount of shortening, which is in part due to the knock knee.

knock knee (Figure 82), subluxation (Figure 84), and occasionally genu recurvatum become evident. Outward rotation (Figure 83) of the tibia upon the femur often marks this stage. It is at this

time in the process that ankylosis may occur and the deformities become permanent and no longer chiefly dependent upon reflex muscular contracture. There then ensues an adaptation of the capsule, tendons, and ligaments about the joint to their new relations, which contributes to the permanency of existing deformity.

**Color and surface temperature.** The term "white swelling," which has been given to this disease, indicates an appearance which characterizes only the more advanced cases. Here the blanching of

the skin is quite significant, but as a rule the milder types are dusky purple or reddish purple in color as though passively congested and this is not uniform over the entire surface. Where suppuration is imminent redness becomes quite marked and the skin thins until it actually breaks down. An increase of the surface temperature is an early and constant sign.

**Swelling, atrophy, and shortening.** Measurements over the knee when compared with the sound side indicate an enlargement which



FIG. 83. Illustrates atrophy of thigh and calf, hypertrophy of the internal condyle and consequent knock knee; lateral displacement of the tibia upon the femur, with outward rotation of the tibia.

is notable from the very outset of the symptoms. The lateral fossæ are obliterated and the joint shows a more or less characteristic swelling. (Figure 85.) Sometimes with calipers it is possible to



demonstrate a broadening of the condyles indicating enlargement in the bone. As has been pointed out in the Section on Pathology an initial lengthening may be demonstrable; this generally disappears and an actual shortening finally occurs.

**Constitutional and functional signs.** In non-suppurative cases in children especially there may be very few constitutional signs, and they do not precede the development of local symptoms. Profound constitutional symptoms occasionally develop after mixed infection in the suppurative cases. Amyloid changes constitute the most common type of such complications. Systemic, miliary infection is rare, but occasionally attends operative measures in these patients.

**Abscess.** Cold abscesses occur, as has been stated, in from twenty to thirty per cent of the cases. They distend the joint sym-

metrically when they open directly into this cavity, but when, as quite frequently happens, they escape the joint capsule by perforating above the insertion of the synovial membrane, then they may appear in the calf or in the thigh, having no connection with the joint itself, but originating in some one of the bones which make up the articulation. The writers have seen instances of their location in both the above-mentioned situations.



FIG. 84. Illustrates the atrophy of the thigh and calf and the subluxation of the tibia in a case of tumor albus. Same patient shown in Fig. 80.

## DIFFERENTIAL DIAGNOSIS

In children the differential diagnosis of tuberculosis of the knee joint is not as difficult as it is in the adult. One has to consider more especially in children syphilis, osteomyelitis, hæmophilia, acute sprains, scorbutus, and infectious arthritis of the type of Still. In adults neoplasms, osteomyelitis, syphilis, spinal arthropathies, the atrophic, infectious, and hypertrophic types of chronic joint disease, hæmophilia, intermittent hydrops, gout, sprains with acute synovitis, villous arthritis, lipomata, internal derangements, particularly displacements of the semilunar cartilage, and hysteric conditions must be considered.

**Syphilis.** The synovial, the periosteal, and the osteal types of lues cause joint symptoms which are very like those of tuberculosis of the knee.

The differentiation from **congenital syphilis** in young children offers the most perplexing diagnostic problem. The syphilitic joint shows a good deal of capsular thickening and there is usually less muscle spasm than in tuberculosis, and the synovial infiltration and osseous enlargement may be less symmetrical than is the rule with tuberculous lesions affecting this joint. A history of parental syphilis and the presence of scars about the mouth and nose and keratitis should be looked for. Snuffles and Hutchinsonian teeth may have some significance. The administration of small doses of gray powder is sometimes of assistance in clearing up the diagnosis.

The form of osteomyelitis which is most commonly a source of confusion is that known as **epiphysitis**. It has an acute onset associated with high fever, great pain, and early suppuration. Cultures made at the time of operation yield positive and conclusive evidence of the pyogenic nature of the trouble. The staphylococcus is generally found in pure culture. The rarer form of osteomyelitis known as "bone furuncle" occasionally occurs in the lower end of the femur or upper portion of the tibia. This is a low grade infection of the diaphysis with either the staphylococcus pyogenes aureus or albus, which causes pain, spasm of muscle, and juxta-articular

swelling. In the X-ray it is often indicated by a definite cavity. Hæmophilia not infrequently gives the first indication of its presence by an hæmarthrosis. The joint swells rapidly, usually after a trauma or a wrench, and is painful and tender to touch. Later on it often becomes discolored. A family history of hæmophilia may be obtainable.

**Acute sprains** in children may occur without the knowledge of parents or attendants. The history where obtainable is valuable, but many times one has to decide on the diagnosis without the aid of such history. The synovitis develops rapidly and there is a notable absence of capsular thickening. Rest and fixation quiet the symptoms very quickly and the fluid quite rapidly absorbs.

**Scorbutus** is a disease not very uncommon among children, especially the very young. On account of bone tenderness and the presence of subperiosteal hæmorrhages which may locate near the knee joint and cause swelling and reflex spasm, confusion may arise in diagnosis. The child will usually be found to have more than one locality affected in this way and the gums often show signs of bleeding.

**Still's type**, which is the type of **infectious polyarthritis** occurring in children, occasionally manifests itself in the knees alone. The changes in the joint develop gradually and might easily pass for tuberculosis unless the case were carefully studied. It is rarely that



FIG. 85. Compare the two knees in this illustration. The left knee is much swollen throughout its entire extent. The limitations of the synovial cavity of the joint can be well seen. Observe the obliteration of the lateral fossæ, atrophy of thigh and calf, and enlargement of the knee. This patient had 30 to 40 degrees of motion in the joint when this photograph was taken. At operation the disease was largely and apparently primarily synovial.

only one joint is involved, in Still's Disease. The process often develops in the train of some infectious process outside the joints. General glandular enlargements and endocardial lesions are present in Still's Disease in a pretty large percentage of the cases. In an X-ray the thickening of the capsule is much more symmetrical and of greater density than in synovial tuberculosis. There is never any involvement of cartilage and bone in the Still's cases. Where there could be any possibility of mistaking the diagnosis, the polyarticular nature of the process would be evident at this stage.

In adults there are many more conditions which may be confused with tuberculosis of the knee joint. Among these we will first consider **neoplasms**. Both the malignant and the benign varieties may occur in such close proximity to the knee joint that the symptoms which they cause suggest a chronic arthritis.

Among the malignant growths giant-celled and periosteal sarcomata are the most common. The giant-celled or endosteal variety develops most often in the lower end of the femur, causing a thickening of the entire lower end of that bone, usually without capsular thickening. They grow rather slowly, and though not likely to be exquisitely painful, as is the case with the periosteal variety, are constantly painful, not being any worse at night than during the day. Eggshell crackling may be sometimes obtained in this type of sarcoma. The periosteal variety develops more rapidly, is much more painful, and is likely to involve more of the shaft of the femur. Spontaneous fracture quite often occurs in cases of this sort. The X-ray is very helpful in the diagnosis.

**Osteomyelitis.** Juxta-epiphyseal osteomyelitis of the acute fulminating type is generally due to pyogenic infection and not to tuberculosis. Absolute dependence cannot however be placed on the acuteness of onset as an indication of the pyogenic character of such a process, though in the great majority of cases it may be so accepted. Bone furuncles located near the femoral or tibial epiphyses may cause symptoms of joint disease. The X-ray will often reveal the true character of these lesions, where the clinical signs are not sufficiently positive.

**Spinal arthropathies.** Syringomyelia and tabes dorsalis give rise to joint lesions which at certain stages may be confused with tuberculosis. When the process has progressed so far as to cause disintegration of the joint and a painless and hypermobile articulation there is not much difficulty in diagnosis. Before these conditions have become extreme or have developed at all there may be much difficulty in coming to a definite conclusion, and under such circumstances careful search must be made for the evidence of these lesions in the central nervous system. There are other spinal arthropathies, but these are the most common.

**Chronic joint disease.** Atrophic, Infectious, and Hypertrophic Types.

These three types are most often polyarticular. The third should never cause confusion in diagnosis from tuberculosis. In it there is little if any capsular thickening, no increase in surface temperature, and usually more or less prominent and palpable osteophytic ridges about the femoral and tibial condyles or on the patella. Muscle spasm is rare in this type unless there has been a recent joint sprain. The first and second types are capable of exclusion in almost every case by the polyarticular character of the lesions. Occasionally there is a monarticular infectious arthritis, but its onset is usually more rapid than is the case in tuberculosis. The X-ray (Figure 86) is of great service in separating these types from tuberculosis.

**Haemophilia** needs no further mention here in a consideration of the adult diseases which may be confused with tuberculosis of the knee. It is only necessary to point out that the presence of bloody effusion in the joints and the organization of clots so located may produce secondary atrophic and hypertrophic changes in the bones and cartilages. If the history of hæmophilia were not known these might be confusing, but where there is this history there would be little likelihood of mistaking such lesions for tuberculosis.

**Intermittent hydrops.** There is a chronic enlargement of the knee joint having regular periods of swelling and recession. This periodicity varies from two- or three-day intervals to nine days or longer.

The swelling begins at a very regular time, the maximum being attained in a certain number of days or hours, and the recession occupying an equally definite period. This period, for a given joint, is nearly always the same so long as the phenomenon continues. The swelling has been largely capsular in the two cases which have been seen at operation by the writers, and does not appear to be due to an excessive accumulation of fluid but to villous enlargement. Motion in the joint is not much restricted and there is relatively little pain. The intermittency and functioning capacity, even when the joint is most swollen, would seem to differentiate it from tuberculosis.

**Gout** does not often localize its lesions in the neighborhood of the knee joint to the exclusion of other situations. Gouty deposits about the knee joint are less diffuse than the infiltrations of inflammatory processes. Their character can be quite accurately determined by the X-ray and tophi situated in other parts of the body can generally be demonstrated.

**Sprains.** Wrenches, twists, and lacerations of the extra- and intra-articular internal ligaments of the joint are commonly recognizable through the history of injury, and are therefore more easy of recognition in the adult than in childhood.

**Villous arthritis.** Chronic enlargement of the knee joint which is confined to the capsule and is palpably of a villous character may be associated with faulty weight-bearing. The symptoms are not sufficiently acute and there is not enough limitation in motion to make a diagnosis of tuberculosis probable.

**Lipoma.** In the upper, outer quadrants of the knee joint and on either side of the patellar tendon on a line with the joint there may be seen and felt local thickenings which are purely fatty or fibrofatty. These may be quite tender to pressure and cause some restriction of motion at the extreme of extension. There is no general thickening of the capsule in these cases and there is little ground for confusion with tuberculosis.

**Internal derangements of the knee joint.** Semilunar displacements are almost always evident from the history of injury and the

character of the symptoms. Sudden, painful locking of the joint, with localized tenderness, most commonly over the internal semilunar, will generally establish a diagnosis. "Joint mice" cause



FIG. 86. This is a case of chronic non-tuberculous arthritis of the atrophic type. Note the uniform thinning of the cartilage and the close approximation of the femoral and tibial condyles, the lack of osseous erosion or capsular thickening. Cf. Figs. 76 and 79.

somewhat similar symptoms, but the detached body can usually be felt and be made to appear and disappear almost at will.

**Hysteric joints.** Functional symptoms are occasionally manifested in the knee joint. They are to be recognized by the preponderance of subjective symptoms over objective signs and by other manifestations of psychoneurosis. The relaxation of muscle and ligament which accompanies protracted cases of nervous prostration often gives rise to articular symptoms in the knee joints, but they are not at all significant of tuberculosis.

## TREATMENT

The management of a case of tuberculosis of the knee joint calls for the employment of some form of apparatus for protecting the articulation from the motions of flexion and extension. Weight-bearing may be permitted in accord with the sensitiveness of the joint. Constitutional upbuilding holds here as in other tuberculous lesions the most important place. Operative measures are chiefly applicable to cases of adult tuberculous joint disease, and except for the treatment of abscesses and the rare instances where an excision or an amputation must be resorted to as a life-saving procedure, they have no place in the treatment of these lesions in the knee joints of children.

The **constitutional treatment**, both its importance and its detail, have already been so extensively discussed that further reiteration of the paramount claims of this phase of the treatment of tuberculous arthritis is not necessary here. Suffice it to say that through the application of this principle by careful attention to all its details the two essential factors in the care of tuberculosis will be attained, viz:—the establishment of constitutional immunity and the isolation of a local focus behind a protective wall sufficiently strong in most cases to prevent further extension and ultimately to wipe out infective organisms or reduce them to an innocuous condition.

Of secondary importance is the **application of splints** for the protection of the local manifestations of the disease. The early application of plaster casts extending from the perineum to the malleoli gives the very best fixation and usually very promptly quiets down muscle spasm and its attendant pain, preventing the development of flexion deformities. In many cases existing deformity may be overcome by the use of such an appliance changed as often as the release of spasm will permit. At first crutches and a moderate high sole on the unaffected leg may be necessary, but so soon as joint sensitiveness has passed weight-bearing should be allowed. When convalescence is established a removeable leather splint should be fash-



ioned over a plaster model and this should be continued until all joint symptoms have disappeared. This will not be, in most cases, until two years or more have passed.

The Thomas knee splint, either with or without plaster fixation, may be used, but in the opinion of the writers has no advantages over the fixation method alone, and does possess some disadvantages over that method.

Under the **operative treatment** we have to consider the eradication of disease and the correction of deformity. Neither condition requires consideration in children, except under circumstances to which reference has been made. In adult patients the indications for operative interference and the selection of methods as well as the technique to be employed in carrying them out have been described in the appropriate section.

In the same place management of the deformities which are the sequel of tuberculous arthritis in the knee joint has been considered. Tuberculous abscesses in the knee joint more often require open incision than elsewhere because of the superficial character of the accumulations of pus in this joint and because at the same time the underlying disease may be removed.

## PROGNOSIS

The prognosis of tuberculous disease of the knee joint in children is good when the conditions are favorable for treatment. From two to four years will usually be required before the omission of all restraint is permissible. This time varies a good deal according to the age of the patient and the severity of the infection. Many of the cases, even the severe ones, get well, with quite good motion at the joint. A little flexion and knock-knee deformity seems unavoidable in some cases, although careful treatment has been followed from the very beginning. The presence of suppuration does not preclude the preservation of a very considerable amount of mobility. In adults under conservative treatment the period of fixation is relatively a longer one than in children, and functional results are very

much poorer. Suppuration is a much more serious matter in an adult than in a child, and the natural history of the process in these patients demands radical treatment much more often than is the case with children and adolescents.

After such radical procedures as erasion and excision in adults the outlook for cure of the disease is good and very satisfactory function of the rigid limb is generally secured in from six to nine months after operation.

## CHAPTER V

### TUBERCULOSIS OF THE TARSAL, CARPAL, PHALAN- GEAL, SHOULDER, ELBOW, AND SACRO-ILIAC JOINTS

IN considering tuberculous disease of joints not already mentioned it should be remembered that while the symptoms in a given joint may vary as the result of peculiar anatomical conditions, the principles underlying the disease and its treatment are, nevertheless, the same as those which apply to tuberculous bone or joint lesions in general. In the first place, it may develop primarily in the bone or in any of the other joint structures. In this group of joints tuberculosis may remain as a local process with little destruction and slight ultimate impairment of function, or it may extend until neighboring structures are involved and serious consequences follow.

The process is here as elsewhere an extremely chronic one, being slow in its onset as well as in its development and final healing. An acute onset with rapid distention of the joints, so commonly seen in acute forms of infectious non-tuberculous arthritis, is rarely observed in tuberculous disease, except when there is a sudden rupture of a diseased focus into an articulation, and even under these conditions earlier symptoms can generally be relied upon to explain such acute features. The character of the swelling is significant. Instead of a distended joint with a thin synovial membrane as is the case in acute infections, there is comparatively little increase in the amount of joint fluid, but marked infiltration of the capsule and periarticular structures, giving a soft, boggy feel and a general fusiform appearance to the part.

*WRIST AND ANKLE*

In the wrist and ankle the connection between the various carpal and tarsal joints is so intimate that if disease starts in either of these regions it is very likely to extend until all of the adjacent joints are involved. If the primary focus is in bone the prognosis in either of these regions is quite favorable, because in its development a



FIG. 87. Observe the thickening of the body of the os calcis and the location of the cavity on the plantar side of this bone about which there is considerable increase in the density.

protective zone of granulations is frequently formed before the joints become involved, in such a way that the local character of the process is preserved and rapid dissemination of infection is prevented. With a more general involvement swelling is diffused, the entire part being soft and boggy; the outline of individual joints disappears, thus differing from a primary bone focus, in which localization of the process and freedom of adjacent joints from disease is usually apparent.

In a primary synovial focus, since the disease is in the soft struc-

tures, development is more rapid and disability more pronounced than with a primarily osseous process, and while the lesion is similar to that observed in the larger articulations, proximity of other joints and the consequent difficulty of applying protective treatment to the affected joint without interfering with the use of adjacent articulations makes it more difficult to manage. With a primary osseous lesion the process may start in any one of the bones and remain as a central lesion for a considerable period, not unlike non-tuberculous osteomyelitic lesions, causing comparatively little discomfort.

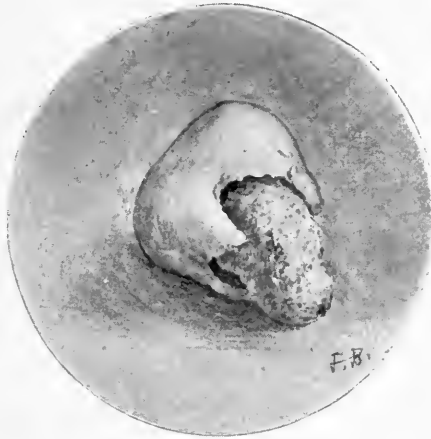


FIG. 88. The illustration was made from a specimen of an astragalus which was tuberculous. Observe the sequestration of the central portion which is protruding from the cortical shell.

Under such circumstances, rheumatism or some such term may offer both to the physician and to the patient a satisfactory explanation of symptoms. With this type the disease may extend and rupture into a joint, healing taking place without any serious interference with the joint motions. This is shown in the illustration (Figure 87), in which the lesion was confined to the os calcis. In childhood, when the bones are partially ossified, disease may develop so rapidly in hyaline cartilage that the ossified portion may be entirely surrounded and become a sequestrum. This is admirably shown in Figure 88, in which the entire ossified portion of the astragalus could be shelled out as soon as an incision was made.

Because of the difficulty of protecting an individual joint in carpal or tarsal disease, there is usually greater destruction of tissue and abscess formation, a much more common occurrence than is to be expected with disease in more isolated joints, and consequently prognosis is not so good, for a much greater impairment of function is likely to ensue.

### *FINGERS AND TOES*

When the joints of the metacarpus, the metatarsus, or phalanges themselves are involved the process is similar in every way to that in the carpus or tarsus, except that inasmuch as the joints are more distinct and more capable of individual treatment there is a proportionate improvement in prognosis. In childhood phalangeal disease is commonly called dactylitis, and not infrequently destroys the cancellous bone adjacent to the joint and extends into the shaft, causing so much destruction that the finger or toe may be considerably shortened. A type known as *Spina ventosa* is a tuberculous osteomyelitis of the shaft of a phalanx, suggesting at times a bone cyst.

### *ELBOW*

Tuberculous disease of the elbow joint (see Figure 89) is similar in many ways to the same process in the knee. The joint is exposed, so that it can be easily studied, and treated either conservatively or radically. It is easy of protection by splints, being sufficiently remote from other joints, and there is ample opportunity in the upper and lower arm for the application of apparatus. The most important point in the treatment of tuberculosis of the elbow joint is the maintenance of the most advantageous position after treatment is finished. A position of right-angled flexion is most desirable and an arm, even though ankylosed in that position, is extremely serviceable. A flail joint, such as is obtainable by excision, is often a very unstable articulation and should not be thought of except in adults.

*SHOULDER*

The shoulder joint, although easy of examination so that a study of the character of the swelling, limitation of motion, X-ray appearance, etc., is not difficult, is nevertheless less satisfactory to treat than the same lesion in some other situations and functional results are more disappointing than is usual in other articulations. This



FIG. 89. Observe the erosion on the articular surface of the ulna.

is due to the fact that often the process extends to the scapula, and not infrequently involves the lymphatics of the axilla and neck so that a general tuberculous condition ensues. In the chapter on the operative treatment of tuberculous joint lesions the common types of tuberculous disease in the elbow and shoulder are more fully discussed.

*SACRO-ILIAC JOINTS*

The sacro-iliac joints may be involved, rarely more than one at a time, and diagnosis is as a rule not difficult. Pain, which is rarely

acute, is referred definitely to the affected joint; swelling over the articulation is usually apparent; the gluteal and lumbar muscles on the affected side are atrophied. The attitude in standing is usually very suggestive of disease in this location. The body is inclined to the side away from the affected joint (Figure 90), so that the weight is carried upon the sound leg, and in walking the peculiarity of the gait is explained by the effort to save the affected joint from strain. The motions of the hip and spine, in so far as they can be made without at the same time straining the sacro-iliac synchondroses, are free, but all motions at these joints in which the sacro-iliac articulations are called upon to participate, such as forward bending of the body with extended knees, lateral bending of the body toward the affected side, or thigh flexing with extended knee, will be limited. When disease is in this joint there is usually considerable bone destruction and abscess formation, because of the difficulty of immobilization. Ankylosis of the joint is the most favorable final result, a condition which in this articulation is not undesirable.

### TREATMENT

The general treatment of tuberculosis in these regions is similar in principle to that which has been described in the previous chapters. Adaptation of these principles depends upon special anatomical and mechanical features presented by the given case.

General treatment is of the utmost importance and no detail of good care or hygiene should be overlooked. Local treatment should consist in perfect fixation as nearly focalized upon the affected joint as is possible, permitting function in neighboring joints to as great a degree as is consistent with a favorable progress in the diseased joint and omitting rigid protective measures even from the diseased articulation as early as it is possible to recognize a cure.

### WRIST AND ANKLE

In the wrist the entire carpus must be protected. The fingers may be permitted some motion, since by their use the circulation may



be stimulated. The elbow should also be unrestrained, so that use of the arm may be allowed to as full an extent as possible.

At the ankle the same principles should apply. The toes need not be immobilized and the knee should have its freedom. It is desirable to give the longitudinal arch of the foot some support in order that in weight-bearing there may be no strain to this part of the foot.



FIG. 90. Observe the list of the lumbar spine, the fullness over the left buttock, the straight line of the right side of the chest and abdomen and the hollowness of the left side.

Occasionally the writers have seen tuberculous lesions of the scaphoid and of the os calcis early enough to be able to recognize an isolated lesion in the joints between the astragalus and scaphoid and the astragalus and os calcis respectively. (Figures 91 and 92.)

To accomplish fixation in either the wrist or ankle a plaster of Paris dressing is the most practical, and in applying it to the foot it can be moulded so that the needed support for the arch may be

obtained. In such a dressing free use may be allowed provided it does not cause pain. The foot should be held at a right angle to the leg, and while walking, crutches should be used, the weight being divided between the foot and the crutches. Because of the arrangement of the bones and joints and the motion which takes place between them, free use of the foot under these conditions is less



FIG. 91. Note the location of the process in the joint between the os calcis and the astragalus; also observe the plantar-flexion of the foot.

often possible than when other joints are affected, but walking should however be attempted and encouraged unless it is attended with pain or other symptoms indicating an increase in activity of the disease. Under such conditions, when it is desirable to protect the foot still more, a Thomas knee splint is of value, the length of the splint being so adjusted that no weight can be borne upon the foot.

If the focus is definitely shown to be a primary bone lesion an

attempt should be made, after a short period of rest, to remove this focus and follow up the operation by protective treatment, it being rarely possible to remove the entire diseased area. The operation indicated in a given case will depend upon the extent of bone involved and its situation. The idea is to expose the diseased area and remove it, recognizing the fact that not infrequently in order to accomplish this an entire bone may have to be excised. For the



FIG. 92. This illustrates an unusually extensive destruction of the body of the os calcis and a fusion of the tibia and astragalus in consequence of an extension of the process to that point.

indications for operative treatment and the details of such operations the reader is referred to the chapter on Operative Treatment.

If abscesses form they should be treated like abscesses occurring in the course of disease in other joints. Aspiration in these superficially located lesions is not as practicable as elsewhere.

In the treatment of tuberculous disease in any region passive congestion, brought about by suction, heat, or an elastic tourniquet, as employed by Prof. Bier, is at times of distinct benefit. Healing is more rapid and the amount of tissue destruction is less. In using passive congestion with the tourniquet, which is the most practical method, there should be no pain and the constriction should be

applied only tightly enough to partially obstruct the venous circulation. Arterial pulsation should never be stopped and the part below the constriction should be only slightly dusky in hue and warmer than the remainder of the limb. It should be employed for one hour daily. In the cases in which there has been an abscess with quite extensive disease this feature of treatment is of special value, and no case, however bad, should be considered hopeless until this method combined with protective splints has been tried. The suction method is most applicable to cases of open sinuses.

It is in the carpus and tarsus, for the reasons given above, that tuberculous disease is most difficult to control, and it is with this, and particularly with the tarsal disease that amputation has most often to be considered. Conservatism should always be tried first, as even bad cases frequently recover, but if it is evident that the amount of bone destruction is such that a useful foot or hand cannot result, or if long-continued conservative treatment cannot be borne by the patient, then amputation should be performed.

### *ELBOW*

When tuberculous disease is located in the elbow, the joint should be fixed in the position of at least a right angle, neither the shoulder, wrist, nor hand being limited in their motion, so that the arm may be used with considerable freedom. To accomplish this a plaster of Paris bandage or a waxed leather splint are the best dressings. In the acute or active stage of the process the former is the better, while later a leather splint is desirable because it is removeable.

Such a fixed dressing should be continued until the signs of active disease have passed, after which it should be gradually omitted, leaving it off at first during the night, at which time a large flannel bandage and soft dressing should be substituted. If there be no return of the acute symptoms, greater freedom may be allowed, both by the omission of the splint and by permitting freer use of the arm.

In cases of tuberculous arthritis of the elbow in children, even though the disease does not soon quiet down, and even though there

are indications of much tissue destruction, conservatism should be the rule, and only in the rarest instances should radical operation be considered. All radical procedures should be avoided unless very clear indications exist of the possibility of removal of the disease without interfering with growth.

With adults the problem is different, and the same rules should be followed as apply to the treatment of the disease in the knee joint. Conservative measures, such as fixation, should always be tried first, but if after six months of this in an early case, or in even less time if the disease be farther advanced, there is no distinct improvement in the local as well as the general condition, more radical measures should be instituted. Usually this means a complete excision of the joint, although the incision should be so made that in case some peculiar condition is present, such as a definitely localized focus, treatment less radical than a complete excision may be carried out.

If excision is performed, the arm should be fixed at a right angle until healing is complete, after which use should be permitted in order to increase local strength and preserve function as much as possible.

### *SHOULDER JOINT*

In disease of the shoulder joint the same principles of protection hold as with other articulations, but are less easy of application, since the shoulder joint is part of the moveable shoulder girdle, with no fixed attachment except the clavicle, and even this moves with the whole shoulder during respiration. The ideal dressing should fix the shoulder with the arm abducted about twenty-five degrees, in which position the muscles which adduct the arm, the pectorals and the teres major and minor, are partially antagonized. The best way of accomplishing this is by means of plaster of Paris, which should extend to the elbow, cover the shoulder, and be moulded to the chest on the affected side. This is held in place by straps encircling the body, which steady it but do not interfere with respiration.

This position is the most favorable for treatment during the acute

stage, and is also the most favorable for function in case ankylosis takes place. It is however more or less awkward, and not infrequently compromises have to be made, the most usual being the binding of the arm to the side and keeping it there until acute symptoms have passed. In this position a stiff joint, which is at best very apt to result in disease of this articulation, is more likely to occur, and the lack of abduction makes the arm less serviceable for use in case it becomes stiff.

Under ordinary conditions with such treatment the disease subsides with a stiff or partially restricted joint and only such limitation ensues as is caused by stiffness. At times however as in other joints, the process does not quiet down in this way and evidences of more marked destruction develop. Even under such conditions, in childhood, conservatism should be the rule, but with adults, when after six months of conservative treatment the process is not distinctly less acute, more radical procedures should be instituted. If it is shown that a definitely localized focus of disease exists, an attempt should be made to remove it. If however the process is more general, the head of the humerus should be excised with as much of the disease in the glenoid cavity and in the neighboring soft parts as it is possible to reach. From the shoulder however as from the hip, it is impossible to remove more than a limited portion of the diseased tissue, in consequence of which firm permanent healing is not to be expected immediately. The wound at the time of the operation should be wiped out with the Tincture of Iodine, and then closed. In case it reopens and sinuses form, these should be treated with sterile dressings without irrigation until they close. In some cases the entire shoulder girdle has to be removed including the arm.

### *SACRO-ILIAC JOINTS*

The treatment of tuberculous disease of the sacro-iliac joints is based upon the principles already cited. The very best of constitutional treatment should be sought, and for local treatment, protection of the joints during the active period of the disease is essential.

To secure the desired protection when the sacro-iliac joints are involved requires some form of lateral support which will hold them firmly together, as it is in this way that motion is limited. This at times can be accomplished by using a canvas belt wide enough to reach from the top of the trochanters to well above the crests of the ilia, but usually it is necessary at the same time to immobilize the lower spine, since motion of this part must inevitably move the sacrum upon the ilium, with an increase in the amount of irritation at the seat of disease. For this purpose a plaster of Paris jacket, a spica, or a waxed leather jacket is the most efficient. In either, the jacket should be fitted well down over the trochanters, with as much pressure over the sides of the ilia below the spines as can be borne. With this apparatus the patient is usually able to get about, although at times crutches are necessary or confinement to bed may be temporarily required. At times additional relief is to be obtained by wearing a belt about the pelvis underneath the jacket. This can be applied more tightly than would be possible with a jacket, alone, and the combination frequently relieves where either one alone fails.

Treatment should be continued until all signs of active disease have passed, the supports being gradually discontinued as the strength and stability of the joints return.

For operative treatment there is little to do other than the relief of special conditions which may develop, abscesses being the most common. These should be treated as suggested in Chapter I.

## CHAPTER VI

### SPECIAL METHODS OF TREATMENT IN TUBERCULOSIS

#### TREATMENT IN SANATORIA

WE believe that certain words should be said concerning the Fresh Air Sanatorium treatment of tuberculosis of the bones and joints. These words should be strong words, for when combined with efficient mechanical protection of the joints the results obtained seem unquestionably more favorable than those obtained by any other known method.

The essentials are obviously the ability to comfortably rest, the freshness and purity of the air, a sufficiency of wholesome, easily digested, nourishing food, constant medical supervision, and opportunities for carrying out the appropriate treatment.

As to the relative value of the high, dry inland altitudes as compared to the advantages of the seacoast air, statistics are too misleading to allow a definite decision. We may perhaps safely reach the conclusion that sea air is at least not deleterious in its influence from the brilliant results obtained by those interested in the treatment of bone and joint tuberculosis in the sanatoria on the coast, such as Calot's at Berck-sur-Mer, Sea Breeze at Coney Island, and the Children's Island off the Marblehead shore. The enthusiastic advocates of this ocean cure feel that the purity and stimulating quality of the salt breezes far outweigh in bone and joint tuberculosis the possible disadvantages of the damper climate.

Different methods prevail in the different sanatoria as to recumbency, ambulation, mechanical treatment, etc., and yet there are reports of general success, irrespective of the exact geographical location of the sanatorium or the special mode of treatment.

We believe that recumbency in as nearly open air as can be safely



obtained at night as well as by day is the ideal early treatment in all cases of spinal, and in many cases of hip and knee joint tuberculosis. It is always to be borne in mind that activity and muscular exercise are of great importance in stimulating nutrition and in calling into action those internal forces which enable the system to most successfully combat the disease. It must always be borne in mind also that in the more active stages of tuberculous joint disease the articular surfaces of the bone are softened, easily crushed, and are capable of much distortion other than that which the pathology of the actual lesion necessitates. Deformity as an end result is a too well-recognized fact to need emphatic statement, and it is the escape from the exaggerated forms of deformity other than that caused by the disease itself that recumbency favors. No mechanical device completely protects the joints of the spine, hip, knee, and foot from trauma when weight-bearing is allowed. In the spine the difficulties are evident and manifold. In the larger joints of the limb, even when efficiently fixative apparatus is applied and the joint is freed from weight-bearing by means of crutches and high sole, it is our experience that in the acute stages the necessarily cumbersome apparatus on the inactive limb produces an atrophy and induces secondary disadvantageous changes in the neighboring joints which do not compensate for the advantages gained by increased activity.

In order to perfectly carry out the recumbent treatment something approaching the sanatorium organization is necessary in the majority of less well-to-do cases of joint tuberculosis. The need of constant attendance and of careful and often skilled supervision is so definite that care of these cases in their homes is a difficult and often impossible condition.

The essentials of geographical location are obtainable within working distance of all large cities and are everywhere at hand in the rural districts. Colony experiments with unemployed but able-bodied persons have usually resulted in financial loss and it is probably true that sanatoria for those affected with bone and joint tuberculosis must be conducted at a still greater loss owing to the

numbers of recumbent patients. This loss, however, may be reduced to a minimum and at the same time the cures may be made more complete and the patients converted into future wage-earners by conducting such sanatoria on the principle of assigning to the more healthy gradually increasing amounts of labor, as is now done in some of the pulmonary institutions. Gardening, poultry-raising, and much of the lighter but more skilled forms of agricultural work may be undertaken by the convalescents and made to yield a considerable income to the institution, especially if directed and supervised by skilled, healthy persons. Such experiments have been successful in certain English sanatoria. The economy to the body politic as these cured cases merge into the wage-earning classes is at once evident.

The cost per bed in such institutions of course varies widely in different nations and in different localities, depending upon the initial expense of the site, the cost of labor, and the number of beds. In some of the English sanatoria believed to have been economically constructed and wisely administered, this cost varies from one thousand to fifteen hundred dollars per bed for twenty beds and a much lessening cost for each additional bed. Most of these are low wooden buildings of the unit construction, offering adequate protection in ordinary extremes of climate. The Bennenden Sanatorium is unique, in that its cubicles are made of separate hollow terracotta blocks of the material known as "Frazzi ware," the foundations required are much lighter and hence less costly than those for brick construction. They are cool in summer and warm in winter; the inner walls are glazed, with round corners, and essentially easy to keep clean. The fire-proof nature of the material is, of course, of immense advantage. The estimated cost per bed, exclusive of site, is about five hundred dollars.

Tents with board floors offer a still cheaper method of construction and afford an opportunity for carrying out this ideal treatment in practically all climates for at least half of the year. With slight ingenuity tents of large size may be made quite habitable even in considerable extremes of cold, and the patients soon become accus-

tomed to degrees of temperature which would at first seem dangerous.

Exile is often a serious matter to these patients and their families, and is nearly always provocative of much mental distress. This uprooting would be no longer necessary if each community would provide by private enterprise or public endeavor an adequate plant where poorer tuberculous patients, irrespective of the anatomical location of their lesions, might have the advantages of this fresh air treatment which Nature offers without cost.

#### THE TREATMENT OF TUBERCULOUS SINUSES BY BISMUTH PASTE

In 1908 Dr. Emil G. Beck published his first paper on the treatment of tubercular sinuses by the use of bismuth paste.

One part of bismuth subnitrate, free from arsenic, is mixed with two parts of boiling vaseline and sterilized. The sinus is dried as well as possible with a strip of gauze. The mixture is cooled to about 110° F., or if it has solidified is heated again until it is quite liquid, and is then injected into the sinus to its full capacity by means of a sterilized glass syringe. The paste is prevented from escaping by a gauze pad, and the injections are repeated, if the sinus does not remain closed, every three days. In old sinuses and abscess cavities it is considered advisable to use a paste which hardens into a somewhat firmer mass as it cools. For this purpose there are mixed with the original paste white wax and soft paraffin, of each a quantity equal to one-sixth of the amount of bismuth, and the injections made as before.

His theory of action is that many of the sinuses remain open not as physiological vents for necrotic material which is constantly forming at the seat of disease, but that, even after the disease has become quiescent and necrotic material ceases to be formed, the walls of the old abscess cavity and of the tortuous sinuses continue to excrete enough fluid to keep the pathway open. By injecting these full of the paste dead spaces are filled, the cavities gradually close down on the material, and the walls of the sinus

dry up. Experience with this method now covers a period of over a year, and there are available many careful reports of results.

Dr. Wallace Blanchard and Dr. John Ridlon of Chicago have very carefully studied the results of these injections in large numbers of their hospital cases. Their experience covers eighteen months and is of great value, and may be summarized as follows.

1. It invariably fails in cases of marked amyloid degenerations.
2. It fails much more frequently in new sinuses than in those that have existed for months and years.
3. It should never be used when the X-rays show a sequestrum.
4. Its continued use is dangerous when large pus sacs become filled with residuary bismuth.
5. It cures a majority of cases of old tubercular sinuses.

These authors open, drain, and inject bismuth paste into tubercular abscesses to full capacity and report that the openings close and the cavities remain sterile. They have not had a case of bismuth poisoning, but recognize its danger in filling large abscess cavities.

In the writers' experience the method is useful and usually successful in those cases in which no fresh necrotic material is being formed at the seat of the disease. Where the discharge is at all profuse and the initial process is still active, we do not expect a rapid or permanent closure of the sinus.

#### INJECTIONS OF IODOFORM OIL, AND OTHER SUBSTANCES INTO ACTIVE TUBERCULOUS JOINTS

The method of injecting substances, especially some of the iodoform mixtures, into joints in which tubercular processes are active, has been extensively employed in this country and abroad. Some of the reported results have been encouraging, and if the diagnosis has been correct not a few may be called brilliant.

Our experience with this method has led us to place little dependence upon it. It seems irrational to suppose that single or even repeated injections of antiseptic substances into acutely affected

joints can thoroughly reach the foci of disease or more than slightly influence the course of the malady. At best it must be looked upon as only a supplement to other forms of treatment, and we believe that if attempts are to be made to eradicate the disease by removing the foci, open incision and actual removal is the most rational, the safest, and the most efficient method.

#### CALOT'S METHOD OF TREATING POTT'S DISEASE

On account of the frequent occurrence and the importance attaching to tuberculosis of the spine, we shall devote some space to a special method of treatment which has afforded unusually perfect and constant results. It is described at length not because it is a special method, but because the principles which underlie it are sound and may be applied even if we dispense with a more or less elaborate technique. This very technique, however, will serve best to illustrate the principles, and until each man works out a method more applicable to his own individual needs is worthy of a thorough trial.

The name of Dr. F. Calot, of Berck-sur-Mer, in France, is associated in most minds with the immediate forcible correction under an anæsthetic of the deformities resulting from tuberculosis of the spine. Calot himself has abandoned this method, which experience has proved dangerous and of doubtful success as regards permanent correction. He still strives, however, to reduce the kyphos by degrees. The reader is referred to an elaborate monograph<sup>1</sup> for a detailed description of his technique and the report of many results now covering a period of several years. As Calot says, all the world is agreed that the treatment of the kyphos in Pott's Disease is important, but not all as to what that treatment should be. He believes that the "redressement" of the kyphos should receive most attention, not only on account of the prevention and reduction of deformity, but also because it is a powerful factor in the cure of the disease. His photographs and X-rays show cases in which the

<sup>1</sup> F. Calot, *Traitement rationnel du Mal de Pott à l'usage des Practitiens*. Paris: Octave Doin, Editeur, 8 Place de l'Odéon. 1906.

kyphos has disappeared and in which the line of the anterior part of the bodies of the vertebræ shows surprisingly slight concavity.

By his method when final consolidation takes place, although new bone does not replace that destroyed, the bodies fuse, the spinous processes are crowded together, instead of being bent apart, and while above and below the seat of the old kyphos there may be found slight concave compensatory curves, the kyphos as such is not evident.

The old, long-standing, exaggerated kyphoses are, of course, least favorable for his method of treatment and frequently resist complete reduction, but all early cases he expects to completely reduce, and the results shown in several cases of long-standing disease and large knuckles are surprisingly good.

He applies his jackets with the patient in light suspension (Figure 93). This extension is not sufficient to lift the soles of the feet from the ground, but enough to gain the erect position and gradually stretch out the kyphos. The head-sling is made from two strips of cloth, 5-8 cm. wide, one passing beneath the chin and over the mental prominence and the other beneath the occiput. These two bands are pinned together at about the level of the ears and the conjoined band on each side fastened above to a

FIG. 93. Position of application. Observe head-sling, anterior crinoline sheet doubled on itself at bottom, and "collar."

spreader, to which in turn the suspending rope is attached. A third strip is pinned in the centre of the occipital band and runs up to the spreader. A closely fitting undervest of stockinette is applied next the skin and continued about the neck and a short distance down the arms. Over the undervest are placed patterns of sheet

wadding or absorbent cotton of considerable thickness. The jackets extend to the level of the trochanters and over the shoulders. When the disease is not higher than the sixth dorsal vertebra only a short neck-piece is added, the so-called "col officier." (See Figure 94.) When the disease is above this point the "grand appareil" (Figure 94 *a*) is applied, which includes the chin and occiput.

The plaster is applied by means of sheets of crinoline. Three or four thicknesses are used for children and seven for an adult. There are two similar sets of these sheets. These are equal in length to one and one-half the length of the trunk and are two or three cm. wider than one-half the circumference of the body. The pattern for the neck consists of a strip of three or four thicknesses three or four cm. longer than the neck circumference and in width equaling the distance from the maxilla to the clavicles.

With the patient in light suspension an assistant holds the arms stretched out in front. A plaster cream is made of five measures of plaster to three of cold water. When this is mixed to an even consistency one set of sheets is folded like a Japanese fan and thoroughly impregnated with the cream. The upper end down the middle to one-third of its length is slit with scissors and the plaster-soaked sheet applied without undue pressure but with nice apposition to the back from the tip of the coccyx to the upper borders of the

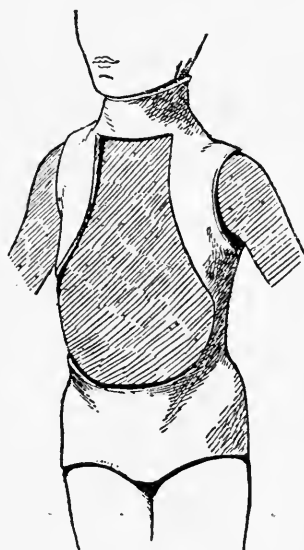


FIG. 94. Jacket for disease below sixth dorsal vertebra. Observe shape of anterior window.

scapulæ, the upper slit ends extending over the shoulders and down over the front of the chest. The second set of sheets is now similarly impregnated and applied over the front of the chest from the clavicles to the mid-thighs, the lower end being next turned upward on itself, making the lower border of the jacket at about the level

of the trochanters and the inferior portion of double thickness. The edges of the two sets of sheets overlap and will fit much more easily and nicely if their edges every five to eight centimeters are nicked with scissors by an assistant as they are being applied. Especially is this true of the region of the shoulders and the arms.

The neck-strips are finally impregnated and applied about the neck without undue compression of the larynx. Additional plaster



FIG. 94*a*. "Grand appareil." Anterior window well above larynx.

cream is well rubbed in over the whole surface and overlapping edges and one or two plaster bandages applied in figure of eight fashion over the shoulders and about the chest, extending a short distance down the arms.

No great pressure is exerted at the time of application over the kyphos, but the jacket is carefully moulded over the iliac crests, while firm pressure is made over the pubis and the sacrum. As soon as the jacket hardens the suspension is released and the patient placed in recumbency. A small window is cut at once in the front of the jacket

and later enlarged, as shown in Figures 94 and 94*a*. After two or three days, or, in case of an especially acute kyphos where there is danger of excoriation, in from fifteen to twenty hours, the patient is turned on the face and a quadrilateral window is made over the kyphos, three or four centimeters larger in all directions than the zone of the disease (Figure 94*b*). The jersey is cut diagonally from corner to corner and the four triangular flaps folded out. Vaseline is rubbed on the skin exposed by the window.

For compression Calot uses squares of absorbent cotton about one cm. in thickness and three to four cm. larger than the dimen-



sions of the window. These are tucked in one after the other beneath the edges of the opening over the kyphos, with fingers or spatula. He uses at the first sitting seven to nine of these squares. A dome of the cotton wool results, which is bound down by turns of a plaster bandage covering over the anterior window as well as the kyphos. Upon hardening, the bandage turns over the anterior window are cut away. This anterior open space is the safety-valve, and the packing should not be applied without the ample window in front having been first made. In fifteen or twenty days the posterior window is again opened and several more squares of cotton

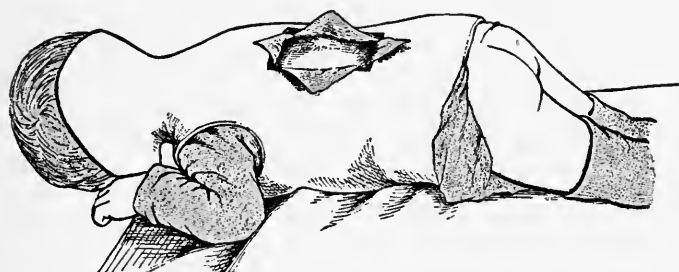


FIG. 94 *b*. Posterior window over kyphos before packing has been inserted.

than were used the first time are carefully packed in, and the same binding-down process repeated. At the end of perhaps two months sixteen or eighteen squares of cotton may be packed in.

At one month intervals the compression is changed. After five or six months a new jacket is applied and the process repeated.

This active treatment should cease when (1) the gibbosity is corrected, and (2) ankylosis is produced. The patient is left recumbent throughout the treatment. In fifteen to eighteen months he expects to reduce small kyphoses. In two years some cases he considers as cured, but more often, three, four, five, or even six years are required.

When from the examination he believes the case to be cured, the patient is given a protective jacket of celluloid with a hinged window for compression over the kyphos. The erect position is resumed, the patients are allowed to walk, and the fixative apparatus is worn for three or four years.

## CHAPTER VII

### THE OPERATIVE TREATMENT OF JOINT TUBERCULOSIS

THERE is a widespread tendency to regard tuberculous joint disease in childhood as particularly suited for mechanical treatment, and in adult life for either curettage, excision or amputation. Such a view inflicts a hardship upon a considerable number of sufferers from joint tuberculosis in adult life, and probably upon a few children. There has been too great a tendency in the past to regard tuberculous arthritis as a local disease requiring fixation aided by extra diet, tonics and good hygiene, or a thorough eradication of the disease with a wide margin of healthy tissue, ignoring the possibility in carefully chosen cases of a functioning joint after such operations and fixations.

The first method, though an essential one, has fallen short of the best results because it has seriously interfered with local nutrition and consequently has retarded reparative processes. Surgical rest is necessary for diseased joints, but should be confined to the affected one as closely as possible. The articulations to which adequate application of this principle has been directed are conspicuously the ones in which the surgeon anticipates the best results, because experience has taught him to expect them. The one articulation where he has been induced to sacrifice somewhat of this principle in order to carry out another, viz., distraction, is notoriously the joint where the worst results are to be seen. The harm resulting from failure to carry out localized fixation is not more serious in its effects than is interference with the nutrition of the limb and the function of adjoining articulations brought on by too complete fixation.

We speak of these matters in this connection because of their bearing upon the cureability of bone tuberculosis, not because we desire to enter into any discussion of the traction treatment of such

lesions. If the above is true there should be more reason for the operative management of selected cases of joint disease than has commonly been believed, for any procedure tending to abbreviate the duration or modify the extent of fixative methods in the care of a tuberculous joint must have a decided therapeutic value over longer and more rigorous methods.

The tendency toward great radicalism in the management of adult tuberculous joints, a tendency particularly characteristic of the general surgeon, is based on two beliefs. The one assumes that an adult can ill afford time for conservatism, and the other that osseous foci will not repair readily in the adult, and consequently the best results are to be had by total extirpation even at the expense of considerable mutilation. The first of these objections is more or less valid; the second is destined to undergo considerable modification, as we come to understand the interrelation of local and constitutional immunity. In other words, it is the belief of the writers that the operative treatment of joint tuberculosis has been too greatly influenced on the one hand by the employment of mechanical appliances, and on the other by a too pessimistic view of the curability of tuberculosis by operation. Occasional sporadic attempts have been made to bring treatment back to a rational basis, giving these two influences their proper rating. These attempts however have been ineffectual, and have usually served to secure to the one making them either censure or cold indifference, usually the latter. It is not the purpose of the authors to condemn conservatism in the treatment of tuberculous arthritis; neither do we propose indiscriminate surgical interference in all adolescent or adult joints, but we do wish to urge surgeons to study these cases more thoroughly, for such study will lead to a better selection of operative material, though it will not necessarily lead to a greater number of operations upon tuberculous arthritis. In this way we shall not be merely adding to the number of major operations, and perfecting their technique, but shall be augmenting the common fund of knowledge concerning bone and joint tuberculosis.

REASONS FOR OPERATIVE INTERFERENCE IN GENERAL IN  
CHILDREN AND IN ADULTS

In children there can be but little difference of opinion with reference to this matter. The fact that as a rule tuberculous disease locates in the centres of growth in bone has served to curb the desire to eradicate foci of tuberculosis in these localities before growth has ceased. Furthermore practical experience has demonstrated that spontaneous recovery, or at least recovery aided by protective and constitutional measures, is likely to take place in the large majority of instances. It therefore follows that except in those very rare circumstances where the focus of disease in the epiphysis is so located that its advance is toward the diaphysis radical surgery should be avoided before the time that growth has ceased, unless it be to save life. Extension toward the diaphysis makes a local extirpation possible. This is not justifiable if miliary tuberculosis is present, and is very questionable where marked signs of amyloid coexist. The treatment of abscesses in children will be discussed in another place.

In adult life radical surgery is practised for the following reasons:

- (a) Impatience of conservatism, or inability to give up time to conservatism.
- (b) Failure of conservative methods either to control or check the local advance of disease.
- (c) Danger of general infection.
- (d) Preservation of function in joint.
- (e) Intolerance of apparatus.

(a) Economic considerations necessarily have to be given their due weight. If estimating the length of time which will be required to restore a patient to wage-earning cannot be more than an approximation, and it is this consideration which is uppermost in the mind of the patient, greater care should be given to the determination of the probable period of total incapacity than is generally accorded. Confinement to bed or detention in a hospital are

not necessarily added items of expense for those who are abandoning conservatism in order to save time, for free hospitals are accessible to the majority of such patients. It is not fair in giving advice in such matters to say that an amputation will call for two or three weeks in bed, whereas an excision will probably require six to eight weeks before the same degree of freedom for independent motion will be acquired. This is doubtless true, but the real question the patient has in mind is the length of time which will be necessary for ultimate recovery, and such an answer as the above, though not intended as such, is in reality a deception. No one is rash enough to assume that an amputation is a completed operation, so far as ultimate recovery is concerned, in three weeks. Such an assumption is particularly unfortunate if the nature of the patient's occupation is such that it could be carried on with an artificial limb, and he is anticipating the resumption of that occupation when he has adjusted himself to that appliance.

If there are not great differences in the times of incapacity between the various radical operations and possible conservative procedures, when ample time is given for post-operative treatment and due allowance is made for the possible failure of conservatism, great caution should be exercised in giving advice on this point, for otherwise the progress of surgery will be hindered.

(b) Conservative methods of treatment in tuberculous arthritis are not particularly attractive to the adult. He is not tolerant of apparatus, and is much less readily entertained and diverted, even when the economic phases of prolonged confinement are not staring him in the face. If two methods of treatment are presented to him, he will choose the radical method in most cases if it is made sufficiently promising as a time-saver. Adult tuberculous lesions, and by that term is meant lesions which have developed during adult life and not the relics of previous disease which have flared up, respond very well to conservative treatment, and as a rule the time required to effect a cure is less than in the child or in relapsed cases. The primarily adult cases that do not respond in this way are quite likely to develop into a fulminating type of tuberculosis.

The adult, however, who is impatient to get about freely, is inclined to ascribe failure to any method the following of which does not bring him at once the evidence of progress. This state of mind is largely due to the lax manner in which advice is sometimes dispensed by those who are perhaps more anxious to practise their surgical technique than they are to give their patients the benefit of their best judgement. Efficient conservative treatment in the adult is generally rewarded by a considerable amelioration of symptoms, and if it gives evidence of controlling the progress of the disease should not be abandoned for radical surgery, particularly if the operation contemplated is one for the purpose of local extirpation of the focus. In general, we think it may be said that conservative methods should not be abandoned in any adult where the patient is holding his own under such methods if the case can be viewed from the standpoint of the surgeon alone. Necessarily occasions will arise when exceptions must be made to this rule, but it should be distinctly understood that such considerations do not change the surgical indications. Failure in the pursuit of conservative measures should be acknowledged only when the patient is losing weight, strength, appetite, and when pain and muscle spasm are not controlled by efficiently applied fixation, or traction, or both. So long as such symptoms as the first three are absent, and such as the last two are lessening, conservatism is not a failure from the point of view of surgery.

(c) The danger of general infection is sometimes assigned as a reason for radical procedures. The danger is a real one, but the occasion for resorting to surgery in compliance with it should be reserved until a reasonable period of conservative treatment has been tried. Even if radical operation has then to be practised the chances are that the patient will be in no worse condition than before it was tried, as there are very few tuberculous joints which are not better for a period of absolute rest before being subjected to operation. Moreover, such cases are fitting subjects for amputation, which is a much less dangerous operation, so far as the chances of dissemination of disease are concerned, than are excisions, either

formal or partial, and also cause less surgical shock. When therefore there is reason to fear a generalizing of a tuberculous process from a joint focus it is as a rule an indication for amputation rather than for any of the less radical procedures.

Local extension is not *per se* an indication for surgical intervention. Increase in the extent of joint involvement, associated with an augmentation of the constitutional symptoms, is reason in most cases for operative interference, always providing there is no obvious occasion for such an aggravation of symptoms dependent upon a failure to follow local or constitutional treatment or that this has occurred in spite of adequate attention to such measures.

(d) A more cogent reason than any heretofore cited for surgical interference in certain tuberculous joint lesions is the preservation of function. The application of any operative measure to a tuberculous joint for such purposes depends upon the relative functional value of the given joint under conditions of faulty position or imperfect motion or both. Evidently a knee or a hip joint may suffer more extensively from loss of motion or faulty position with less functional impairment than an elbow, a shoulder, or an ankle. Therefore the surgeon may with greater propriety direct his endeavors toward the early excision of tuberculous foci in joints of the latter type, purely for the sake of securing a lesser degree of functional impairment, than is necessary in the hip or the knee. Obviously operations having this goal in view must be performed much earlier in the course of the disease than when they are carried out to prevent extension, and the cases suitable for such procedures must be selected with great care.

(e) Substitution of operative measures for splints and general hygienic treatment merely because the patient frets under their application is poor practice. If apparatus is irksome it is often because it is inadequate to the patient's needs and changes which tend to make it more efficient may render it more tolerable. Again it is frequently the fault of the adjustment of the brace which causes the patient annoyance; attention to seemingly minor details of this sort will frequently render comfortable and efficient an otherwise

defective splint. In most cases a careful explanation to the patient of the objects of conservative treatment and the advantages of it over radical measures in his particular case will secure his co-operation in the pursuit of conservative measures.

Operators have doubtless all experienced disastrous results and dismal failures in the operative treatment of these lesions. Barring the common and usually unavoidable, because unforeseen, surgical accidents, all such failures or disasters are due to errors in judgement in the selection of the proper method of procedure, or in choosing the opportune time for interference. As a rule the failures to accomplish the purposes sought are attributable to the selection of an inappropriate method, whereas the disasters are the result of operating at the wrong time. In a later section we shall speak of the failures; here we shall endeavor to point out a way to avoid the disasters.

This avoidance depends upon both the local and constitutional resistance of the patient. Flabby, anæmic, asthenic individuals with poor appetites, having acute trouble in a large joint, are poor risks for operation. A hectic temperature in addition to the above-mentioned physical signs does not necessarily indicate a more serious condition. It means that one of two conditions is present: either a miliary process, already well advanced, or a secondary pyogenic infection. If it is the former any operation is contra-indicated; if the latter systemic resistance may be greater than when the patient is carrying only the small amount of fever which commonly characterizes an unmixed tuberculous infection. In the writers' experience the type of patient above described with an evening temperature of from  $99^{\circ}$  to  $100^{\circ}$ , has been the one in whom dissemination of the tuberculous infection has followed extirpative operations such as excision and erosion. But these were cases in which the subsequent history proved that a miliary process was present at the time of operation. These conditions may obtain in a joint the local symptoms of which are not especially severe. The three disasters which we recall have been in connection with excision of the hip. The surgical difficulties of an amputation at the hip joint in these cases seem so much greater than those of an excision that one is persuaded to the



latter course rather than to the former. The indications however in such cases, whatever may be the ultimate surgical procedure, are to build up the patient's constitutional resistance, and along with this will be built up his local resistance; in other words his osseous or synovial focus will be more firmly encapsulated. Since Wright has introduced a method of determining the opsonic power of a patient's serum, we have a means of estimating with some degree of accuracy his probable immunity to general infection. As yet we cannot affirm that it is a positive test, but experience in its use as a diagnostic measure and also as a guide to the administration of Koch's new tuberculin in treatment, encourages us to the hope that we have in it a valuable aid for solving this most difficult problem of determining when it is safe to interfere in patients who are on the borderland of generalized infection, upon which class of cases operative interference has so frequently resulted disastrously. A period of rest in bed and absolute quiet to the affected joint will frequently have the same effect as is produced in the active tuberculous lesions of the lung where recumbency is enjoined. A few weeks suffice to quiet down the process and local walling-off has an opportunity to become more firmly established. In a local focus upon which an operation seems indicated the accomplishment of such a walling-off is of course of the greatest advantage, and particularly so when at the same time constitutional resistance is being augmented.

The surgeon who operates upon tuberculous joint lesions will find that in the proportion that his knowledge of the significance of gross pathological changes increases, his successes will increase and his failures will diminish. The diminution of his failures is not the result of a better technique, but because he operates less, and when he does operate, suits his procedure to the conditions as he finds them within the joint. In the old view a tubercular joint was in a measure a malignant process, and the more radically it could be removed the better. No regard was paid to preservation of as much of the bone as possible in order to minimize shortening. No regard was had for the utilization of cartilage remaining intact in such a position as to be available for possible motion. No weight was

attached to the question of primacy of the focus, whether in the synovial membrane or in the bone. No consideration was given to the extent to which reparative processes had gone on within the joint, and no attempt was made to find out whether the active tuberculous granulation tissue did or did not preponderate over the cicatrizing or repair process. The general condition of the patient was casually noted, but solely for the purpose of determining the operative risk, not at all as a factor in estimating the probable value of the patient's capacity to overwhelm whatever tuberculous tissue might perchance escape a thorough attempt at removal. As a rule the operator does not keep all of the essential facts in the history of the case before his mind. The object of taking the history is too often solely for the purpose of establishing the diagnosis. It should be of great value in the determination of the choice of surgical methods. The foregoing remarks apply to adult cases more especially, for it is in that class that operations are most often considered.

Primary joint disease in adult life is a different condition, operatively considered, from relapsed disease, the relic of a previous arthritis in childhood. Disease which has suppurated in childhood and relapsed in adult life may merit different treatment in an operative way from non-suppurative but relapsing disease. Relapsing disease and coexisting deformity at the seat of disease demand special consideration.

Most of the questions here raised must be settled with such aid as the history may bring after the focus to be eradicated has been exposed to view. The gross appearances of tuberculous foci are quite significant of the stage of the disease. The writers do not presume to affirm that gross inspection will invariably indicate the presence of active advancing disease, nor on the other hand, of innocuous benign granulation or cicatricial tissue, but we do affirm that its appearance, taken in conjunction with the history and the distribution and extent of the process within the joint, is significant of the infectivity of that process, and enables one who will give attention to such matters to secure more satisfactory results than when following less discriminating methods.

It is often possible, aided by previous X-ray examination, to uncover the original focus in the bone, and by comparison of the cicatrizing tissue about it with the actively spreading, vascular pannous extending from it, to determine whether active disease or reparative processes are in the ascendancy within that joint. It is not necessary to remove every tubercle from an infected joint; that probably has never been accomplished in any excision ever performed, and yet a great many excisions have resulted in a permanent cure. It is common experience to find a large part of the synovial cavity of an articulation entirely shut off from the rest of the joint by an encapsulating envelope within which is the diseased tissue, motion being permitted to a degree consistent with entirely satisfactory functional use. For some reason there is an exacerbation within this envelope. On opening such a joint the portion of the cavity outside the inner envelope is found entirely free from disease. It would seem that under such circumstances there is an unusual opportunity to remove a slumbering focus with the utmost prospect of success, and at the same time preserve the greater part of the motion which the patient has found adequate for the performance of his tasks. In many cases we are surprised on opening tuberculous knee joints to find how much of the articular cartilage of the femur or tibia has been destroyed,<sup>1</sup> and that the patient has yet had good motion and satisfactory function. The writers believe that when the primary seat of disease is in the synovial membrane and an extension from this tissue to the bone has occurred, the synovial process can be eradicated and the bone focus satisfactorily removed in most cases without excision. The determination as to whether an erosion or an excision should be the operation selected must be decided first by the extent to which the cartilage is eroded, and secondly by the distribution of this erosion. If so much cartilage is destroyed as to make it improbable that as much as 25° to 30° of motion will be preserved in such a joint as the knee, then erosion is contra-indicated, or if, an equal area of eroded cartilage existing, this is so situated that eroded portions of the apposed trochlear surfaces will be brought in

<sup>1</sup> Vide Case IV, pp. 219-220.

contact with each other within the  $25^{\circ}$ – $30^{\circ}$  range of motion which is involved in ordinary use, excision should then be the operation of choice. If the bone foci are confined to one side of the joint, — e. g. wholly to the tibial condyles, or wholly to the femoral, with only secondary synovial involvement — the opportunity for successful erasion is greatly enhanced. One of the best results which the writers have had has been in a patient in whom the entire external femoral and external tibial articular cartilage was removed, together with a considerable portion of the bone beneath. There was a good-sized cold abscess as well as very extensive soft-part disease in this case. The internal femoral and tibial trochlear surfaces have been sufficient to ensure  $35^{\circ}$ – $40^{\circ}$  of free motion for this patient.

Central or primarily epiphyseal foci which have broken into the joint, and especially if they have extended from one bone to another, even though the second bone be only superficially involved, are better treated by excision.

The question as to what operation shall be employed when once surgical interference has been decided upon cannot be always definitely determined before the opportunity to study the gross conditions within the joint has presented itself.

Four procedures have to be considered in treating tuberculous lesions, — viz., local extirpation (including erasion); excision; amputation and osteotomy.

As a general rule the first two of these procedures when undertaken should be undertaken with the understanding that they are essentially exploratory, and that either one may eventuate in the other after the joint has been opened, or may possibly result in amputation. The necessity for an amputation can however usually be determined upon without an exploratory incision.

**Local extirpation. Excision.** In the adult patient evidence of good resisting power to tuberculosis, determined by the general condition and possibly by testing the patient's blood for the presence of opsonins, the absence of tuberculous foci in any of the viscera, and the presence of some motion in the affected articulation, even though it be slight in amount and guarded to some extent by

muscular spasm, gives promise of successful removal by local extirpation. If suppuration has taken place excision is much more likely to be the operation of choice; also if irreducible deformity exists local extirpation is likely to fail. The cases suitable for excision are those in which there is evidence of the constitutional effects of tuberculosis, a joint with signs of active disease as evidenced by spasm and immobility, or the presence of abscess or deformity. Excision is not as imperatively contra-indicated in joint disease complicated by pulmonary phthisis as local extirpation would be, but the prognosis in an excision under such conditions should of course be more guarded. The writers have frequently seen a phthisical process become inactive after excision of osseous foci, as though the patient were able to control one tuberculous focus, whereas two were too great a tax on his immunizing powers. It should be the rule we believe in such matters to excise if the joint lesion seems the more active process. If, on the other hand, the pulmonary condition seems the more acute surgical interference is of very questionable propriety.

Genito-urinary tuberculosis is next in order of frequency as a complicating factor in the treatment of tuberculous joint disease. The indications for operative interference upon joints in the presence of this complication are about the same as in a case of pulmonary tuberculosis. Amyloid conditions in the liver and kidney should contra-indicate any surgery except that for the relief of the pain of an abscess or some such similar cause.

**Amputation** for tuberculous joint lesions is becoming less and less frequent. Earlier diagnosis and the success attending conservative treatment are doubtless responsible for this. In the last five years at the adult Orthopædic Clinic of the Carney Hospital only four amputations have been performed for tuberculous joint diseases; two of these were for disease of the tarsus, and the amputation was made at the point of election. One thigh has been amputated for knee joint disease and one forearm for carpal disease. A large number of excisions have been performed, and so far as known there has been no reason to regret the selection of that procedure

rather than an amputation. One of the above-mentioned amputations was first subjected to excision. The thigh amputation was a case in which local extirpation was unsuccessfully attempted, and its failure was due to the improper estimate put upon the patient's resisting powers. He had had phthisis. This was stirred up by his erosion, but subsided after the amputation, and is now quiescent, one and one half years after the major operation. Amputation should be reserved for those cases where a major joint is involved and where great constitutional disturbance is in evidence, with very low resisting power, or the presence of pulmonary or renal complications. In such cases, when locally there is a large area of diseased tissue from which absorption is taking place, it is often desirable and sometimes imperative, if life is to be saved or a military condition is to be avoided, that the diseased joint be radically eliminated by an amputation. It is often disastrous to open into such diseased areas, and is much better surgery to get well above them. Another reason for the employment of amputation is found in the relative functional value of an artificial versus a natural limb after the latter has been subjected to the ravages of disease. Such a question comes up most frequently in tuberculosis of the tarsus. An ankylosed tarsus in good position and free of disease is better than an artificial limb, but excision of small bones from the tarsus when it leaves a painful, though mobile weight-bearing surface free of disease, is not so good as an amputation, followed by a well-fitting wooden leg. If following excision crutches have to be used in order to get about, the operation is a comparative failure. It is not good surgery to strive for that result.

The length of time during which any joint disease has lasted is of considerable value in deciding upon the most promising operation. Adolescent disease which has quieted down and remained so for a long time, if seen when just lighting up is most favorable for local erosion, because such a history means that the patient must have been able to ward off the process with comparative success and that the evidence of disease will be found confined to some well-isolated portion of the joint cavity. Primary adult disease, when

seen early, is favorable for local extirpative methods, though occasionally excision or amputation may be indicated for considerations outside of those which are purely surgical.

**Osteotomy.** It has seemed proper at this time to refer to operative measures connected with the treatment of tuberculous joint lesions which are not usually considered when the treatment of these diseases is under discussion. Tuberculous joint diseases are healed by local encapsulation, and unfortunately there is generally more or less deformity present. A great many relapses of apparently healed processes take place. Some of these are unquestionably due to constitutional debility, but the great majority of such relapses are the result of local strain and breaking-up of the protective encapsulating wall about the partially healed focus. The greater the deformity the more the strain, and therefore the more frequent the relapses. The inference to be drawn from this is that no considerable deformity should be allowed to persist after a tuberculous focus has become quiescent. The most conspicuous example of the efficacy of procedures of this kind is in connection with the correction of flexion and adduction deformity at the hip by means of a trans- or subtrochanteric (Gant's) osteotomy. In other situations however it is equally valuable, viz., in the knee and ankle. (Vide Cases II, III, and IV, pages 216-220.)

Operations of this sort are usually advised for the purpose of improving the appearance and facilitating the use of the limb, but of greater importance than either of these considerations is the diminution in the liability to exacerbation of the disease itself on account of the resulting freedom from joint strain.

Having discussed in general the question which seems of chief importance in determining the choice of operation, there remain to be considered certain questions which grow out of local anatomical conditions in the various joints.

We suppose all are agreed that for those articulations which are concerned in locomotion, ankylosis in a favorable position is the best result to be obtained after extirpation of extensive disease. Such articulations are those of the Tarsus, the Knee, and the Hip.

**Tarsus.** Occasionally an isolated focus in one of the small bones of the tarsus may be removed without causing such a weakening of the foot as to make an anchylosis of the joints in proximity to the disease necessary. If this tibio-tarsal articulation remains intact very extensive removal of the anterior tarsal bones may be undertaken. The same is true of the posterior portions of the tarsus including a very considerable resection of the os calcis, the joint between it and the astragalus and the posterior portion of the astragalus, provided enough of the latter bone is left to secure an anchylosis with the tibia. Otherwise an amputation at the "point of election" is advised. (Vide Cases I, II, and III, pages 214-220.)

It is difficult to discriminate between a resection and a local extirpation in the tarsus because of the small size of the bones and the multiplicity of their articulations. Amputation for disease of this region is only justifiable from a surgical point of view when extirpation of the disease by conservative measures will leave a functionally weak foot, and as a rule this is true of extensive resection of that portion of the tarsus posterior to the mediotarsal articulation. If amputation is decided upon it should be the typical lower leg amputation rather than one of the tarsal amputations. Plantar-flexion of the foot should not be allowed to persist, and if it cannot be prevented during the progress of the disease should be corrected after the active stage is over by a supra-malleolar osteotomy. (Vide Cases II and III, pages 216-218.)

**Knee.** In the knee joint an anchylosis should be the object sought, unless enough articulating surface can be preserved to ensure sufficient motion for function. In a previous section this has been discussed. The production of a pseudarthrosis in this joint is bad surgery, particularly so after tuberculous lesions, — bad because if the disease is not eradicated it will require prolonged fixation and anchylosis to give any result. If it is eradicated the results of operations upon the knee joint do not give enough motion, accepting Murphy's own statistics of motion preserved in the best of his cases, to justify the employment of such a measure. (Figure 95.) Amputation at the lower third of the thigh gives a good functioning



leg with an artificial limb, but happily has rarely to be considered and those considerations have already been dealt with.

Even with the exercise of great care flexion of the leg can rarely be overcome during the active stage of a tuberculous arthritis of the knee by manipulation. Permanent flexion in excess of  $15^{\circ}$ – $20^{\circ}$



FIG. 95. Case of tumor albus which has recovered with a certain amount of motion but extreme deformity in flexion. The motion which she has is represented by the two Figures (a) and (b). Such motion could be only an aggravation with so much deformity.

remaining after the acute process is quiescent should be overcome by Macewen's osteotomy. Occasionally some motion will coexist with an amount of permanent flexion which is inconsistent with function of the leg. If the flexion is not too great and the amount of motion is great enough, i. e.,  $25^{\circ}$ – $30^{\circ}$ , Macewen's osteotomy will correct the deformity and permit the employment of the existent

motion in a position of the leg where it can be advantageously used. If the flexion amounts to a right angle or near it, there will in all probability be no motion to preserve, but a wedge-shaped osteotomy will be better than the linear in such cases. This will rid one of the angularity which would result from the Macewen, and can be performed in two stages in order to avoid the risk of rupture of the popliteal vessels after too rapid an extension of the long-flexed leg.

**Hip.** In the surgical treatment of tuberculous disease of the hip joint there are practically only two operations to consider, — viz., excision and osteotomy. R. T. Taylor of Baltimore and Bloodgood of the Johns Hopkins Hospital have both advocated erosion of this joint, but the results have been unsatisfactory both as to extirpation of disease and ultimate function. The difficulty of reaching the disease when situated on even the most favorable portion of the head of the femur is very great. When located in the acetabulum, as it so frequently is, it is even more difficult of removal. If the process is synovial, as is invariably the case wherever it may be located in the bones, it is practically impossible to dissect out enough of the membrane to prevent further extension of the disease. This leaves the alternative of an excision. Except as a life-saving procedure in cases where great absorption is taking place, excision should not be employed. If used in the early stage of an adult disease there is no question of the ability to secure a pathological cure, but the functional results of an excised hip joint are usually very bad. The total period of incapacity will be far less in a case treated conservatively which results in ankylosis in good position than it will be in the best result obtainable after an excision. (Vide Case ix, page 232.)

Amputation at the hip joint for disease of the head of the femur alone would be unjustifiable. The mortality of the operation in non-tuberculous conditions is high, and a patient who had suffered from a tuberculous process of sufficient grade to make such a procedure necessary would, of course, be a poorer operative risk than the non-tuberculous patients. When the acetabulum is involved the question

of the advisability of a resection of the innominate combined with an excision of the head of the femur arises in a few cases. Four cases of such innominate resection are on record with one recovery. The writers add another case which died on the ninth day after operation from shock and sepsis. (Vide Case v, page 221.)

Dr. E. H. Bradford has suggested the advisability of operative dislocation of the head of the femur in suppurative acetabular disease in order to secure better drainage. Murphy's pseudarthrosis may have a place in the treatment of healed tuberculous disease of the head of the femur and acetabulum.

In the upper extremity the anatomical conditions are so different that in the joints here concerned ankylosis is undesirable.

**Shoulder.** Tuberculous lesions of the shoulder joint are much more amenable to surgical treatment than are the same sort of lesions in the hip. It is possible to eradicate disease and the interference with function is much less serious after complete or partial resections of the head of the humerus than in the joints of the lower leg and thigh. When the process is primary in the glenoid or is allowed to extend across from the humerus to the glenoid, the surgical treatment becomes a much more serious affair, both as regards the possibility of extirpation of the disease and ultimate functional use of the arm. If the disease is recognized in its early stages, and there should be no difficulty in doing this, local resection of the diseased portion of the head is feasible. (Vide Case VI, page 224.) If the capsule of the joint is extensively involved as well as the humeral head, a formal excision is advised. After a thorough removal of disease careful and persistent after-treatment with passive manipulation and massage will give good functional results. (Vide Case VII, page 228.) Extensive disease of the scapulo-humeral articulation occasionally demands a resection of the shoulder girdle, leaving the humerus. Such a procedure is of course reserved for cases where extirpation of disease is imperative as a life-saving measure. The functional results are poor.

**Elbow.** In the elbow joint, failing in conservatism, in an adult we have recourse to practically only one operative measure, — viz.,

excision. The complicated character of the elbow joint makes it impractical to attempt partial resection in the endeavor to remove disease. Even should this prove successful the chances of motion are very slight. An ankylosed elbow in a position of a little more than right-angled flexion gives a serviceable arm, and this is the result that should be striven for in superficial disease of the bones of the elbow or in processes which are chiefly synovial. Where however the process is more advanced in the bone, a formal excision should be seriously considered. This gives one the opportunity of eradicating the diseased tissues thoroughly and at the same time may give a fairly useful arm within certain limits, though it is frequently necessary to wear a splint to prevent subsequent lateral mobility at the joint. (Vide Case VIII, page 231.)

**Carpus.** The carpal articulations are trying ones in which to treat tuberculous disease. The proximity of the tendon sheaths of so many important muscles controlling the essential motions of such an important member as the hand make the problem of a thorough removal of diseased tissue, combined with the preservation of a reasonable degree of functioning capacity, a serious one. The carpal bones are small and an early diagnosis is absolutely essential to the prevention of an extension to such a degree that the whole intricate network of synovial pouches be not involved. If this occurs it is almost inevitable that other bones of the carpus become infected also. Excision of individual bones is sometimes possible. More often the distal row may have to be excised in their entirety and even occasionally the entire carpus has to be removed. When this is the case the reasons for not doing an amputation must be very strong. In these cases where the carpus is so extensively diseased the tendon sheaths are also involved, and under such circumstances amputation will give the assurance of having satisfactorily solved the main problem in the treatment of any tuberculous process, viz., getting rid of the disease itself. The writers report in the last section cases to illustrate both of these conditions. (Cases x and XI, pages 235 and 236.)

The surgical treatment of "cold" abscesses has perhaps under-

gone as great a variety of modifications as any other one method in orthopædic surgery. Some have advocated leaving them entirely alone and allowing them to break spontaneously. Especially has this method been advocated in children. Others have advised early open incision and removal by curettage of the so-called pyogenic membrane, and where possible the underlying bony focus. Injection of the cavity after aspiration with various substances supposedly antagonistic to the tubercle bacillus, e. g., emulsions of iodoform and glycerine, iodoform and ether, cinnamic acid, etc., etc., have been tried. The attempt by open incision to get rid of the abscess and the cause for it at the same time is the ideal striven for, but unfortunately this is rarely possible. Baer of Johns Hopkins has reported success by this method in the treatment of psoas abscesses where the bone focus from which they emanated was situated on the bodies of the lowest dorsal and upper lumbar vertebræ, making it possible to do an extra-peritoneal erosion. In other situations this has as a rule been an unfruitful procedure. The results of the various injection methods have been unsatisfactory. Permitting the abscess to pursue its own course, opening it only when it was so close to the surface that it seemed only a question of where it should point, found favor because it was discovered that secondary infection did not occur with quite so great frequency under such circumstances. In some cases however there were serious results from the harboring of that sort of material within the patient, and its removal became a matter of importance. The impossibility of preserving strict surgical asepsis in the after-care of cold abscesses which are incised and drained has made it necessary to employ some other method than any of those so far mentioned. Aspiration of the abscess gives us at once a method of treatment which meets all the conditions that it is necessary to meet and which it is at the same time practicable to meet. E. B. Young, some six or seven years ago, investigated all the cases of psoas abscess which had been operated upon in this community for a long period of years, and found that the larger proportion of them died within about four years after they were operated upon and that

death was due to secondary pyogenic infection. Rarely since aspiration has been practised as a routine measure in the Hospital Clinic have we seen secondary infections in this class of cases. In adults it can be employed under local anæsthesia only; at most it may be necessary to give "nitrous oxide." A large-calibred trochar should be used, as flocculi may occlude the lumen of a small aspirating needle. Occasionally these cavities contain flocculi of such large size that the lumen of the trochar is occluded and a small incision is necessary. The cavity should be as completely emptied as possible and an antiseptic dressing put on to seal the skin wound. It will almost always refill quite rapidly, but successive aspirations will be found to be separated by wider and wider intervals of time. The writers have aspirated a double psoas abscess nine times during a period of seven to eight months without secondary contamination. The method is peculiarly adapted to adults and to psoas and hip abscesses. Abscesses in the smaller joints of the upper extremity, the knee and ankle are not readily treated in this way. Puncturing abscesses repeatedly in children might be difficult if not impossible on account of fright, but whether the end justified the means in a given case must be determined for the particular child. The method of swabbing out with strong carbolic acid and absolute alcohol still has its advocates, but has nothing intrinsically to recommend it, and we fail to see any particular advantage for it over any other method. Iodine used to swab out a cavity in which there has been tuberculous pus has certainly seemed to possess certain very decided anti-tuberculous germicidal power; whether this was due to the stimulation of the local tissues or to an antibacterial property it is impossible to state. Senn and others have reported enthusiastically upon its use.

The management of the intrathoracic, mediastinal cold abscesses presents at times one of the most trying and imperative of surgical emergencies. The posterior mediastinum is their usual seat and the peculiar surgical emergency they give rise to is that for the relief of dyspnoea or cardiac inhibition. Pressure of an abscess upon the nerves controlling respiratory action demands immediate relief. On account of the spinal deformity usually existing in these cases it is

very difficult to reach the abscess, and the surgeon is further perplexed by the knowledge that because of this same deformity important and vital anatomical structures may be in the way and out of their accustomed situation. The writers have had the misfortune to lose a child on the operating-table from shock before the abscess was reached, and have operated upon an adult where the symptoms pointed unmistakably to a posterior mediastinal abscess, but it was impossible to reach it without prolonging the operation unjustifiably, and the dyspnoea continued for two weeks until the patient's death. No autopsy.

Costo-transversectomy gives the best access to such accumulations of pus.

In regard to the method of treatment of abscesses which are encountered in connection with the attempt to excise tuberculous bone or joint disease, it need only be remarked that they are sterile so far as pyogenic organisms are concerned, and their presence needs no special care either in regard to contamination of the incised soft tissues or the bone, and only such provision for post-operative drainage need be made as one would naturally make. It is in these cases that the Tincture of Iodine, used to swab about freely in the tissues where pus has been confined and over tissue by which it has been contaminated, has seemed to us most efficacious. Although this drug has been freely used no case of Iodine poisoning has been noticed in the writers' experience. The writers have three times opened into a residual abscess cavity in the femur while performing a Gant's osteotomy and given the pus of a cold abscess access to the freshly cut surfaces of the bone at the site of the osteotomy without any untoward effect either in the healing of the soft parts or the union of the bone.

In conclusion a word of caution to those who are called upon to care for sinuses connecting with cold abscess cavities. These sinuses should be aseptically dressed and as infrequently as possible. A good free sinus established to the seat of the disease does not long require to be wicked and thus a fruitful source of contamination is avoided. It is a mistake in most cases of cold abscess

to irrigate. The tubercle bacillus is not present in the pus in great numbers and it cannot be dislodged from the tissues by irrigation. Frequent curettage is productive of more harm than good. When anything is to be done it had better be a radical step toward removal of the disease.

A study recently made for the writers by Drs. Walker and Medalia in the pathological laboratory of Tufts Medical School has shown that in fifty per cent of the cases of cold abscess which were aspirated under aseptic conditions tubercle bacilli were demonstrable on smears made from the pus at the time, thus showing that the dressings from a cold abscess, particularly during the first few days after being opened, should be treated with some respect, as they may readily become a source of infection. The following illustrative cases are added in order to exemplify the principles of treatment here advocated and in certain instances may be of some service in demonstrating the value of X-ray examination in arriving at a diagnosis. It is only fair to say however that the history and customary methods of physical examination are of much greater value either alone or collectively than is the X-ray examination alone.

**Case I.** E. E. E. Male. Age, 45 years. Married.

Complaint — tuberculosis, left ankle. Duration — four years.

Nine months from the beginning of the trouble, incision and drainage. During the next three or four months opened four or five times. Two years ago Dr. E. G. Brackett operated upon the ankle, and considerable improvement followed. Six months later a second operation, and six months later still a third operation was performed.

June 16, 1905. (Figure 96.) Entered Carney Hospital for further operative treatment. Incision through old opening on both sides of ankle. Through the inner incision considerable cicatricial tissue was cut out. Necrotic bone was curetted from the astragalus and scaphoid and internal cuneiform. Some osteoporotic but healthy bone exposed all about this cavity, and the adjacent soft tissues dissected away. The disease seemed to run down into the articulation between the scaphoid and the cuneiform where it was



impossible of removal without too much mutilation. Through the outer incision a small osseous focus was excavated from the cuboid close to the os calcis; the contiguous soft parts were also removed. Swabbed with Tincture of Iodine. Iodoform wicks to both sides. Amputation at point of election will probably be necessary. Ischio-rectal abscess with numerous sinuses on both sides of perineum discharging pus.

June 25, 1905. — Wicks removed. Considerable discharge. Greenish yellow exudate in sinus. Dressed with myrrh.



FIG. 96. Tuberculosis of the tarsus. After radical removal of a large part of the astragalus, the scaphoid, and portions of the cuboid and external and middle cuneiform bones. The foot is in good position for weight-bearing, and the sinuses have entirely healed. The functional results are excellent. The reason for this is that the tibia, what remained of the astragalus, and the os calcis have fused. Compare with Figure 108 where the functional result is poor, though the pathological result was perfect.

July 1, 1905. — Surgeons operated on ischio-rectal abscess.

July 15, 1905. — Discharge less. Cavity nearly healed. To be dressed at home. Discharged.

August 3, 1905. — Readmitted. One week ago pain and soreness on inner side of foot just below scaphoid. Spontaneous opening of abscess. Opening enlarged in the Out-Patient Department. Opening on outer side healed.

August 4, 1905. — A small abscess has again appeared. Incision over fluctuating area with escape of small amount of pus.

August 10, 1905.—Incisions healed. Discharged.

July 19, 1906.—Readmitted. Considerable puffiness over upper surface of cuboid and external cuneiform. Bluish area size of a dollar. Discharging sinus.

July 20, 1906.—Incision two inches long over outer surface along sinus. Necrotic tissue curetted out. Cavity lined with dense fibrous tissue. At bottom of cavity a small area of necrotic bone curetted. Iodine.

July 25, 1906.—Stitches out. Slight discharge.

Feb. 1907.—A small collection of pus given drainage under local anæsthesia over the extensor proprius pollicis tendon opposite the joint between the first phalanx and the end of the metatarsal, evidently a gravity abscess from higher up. Original sinus is healed solidly. Foot in good position. Is able to work 14-16 hours per day as attendant in a pool-room and is in good general condition. Ischio-rectal abscess is not healed.

**Case II.** G. J. R. Male. Entered the Carney Hospital September 27, 1903. Age, 28. Single. Machinist. Duration—one year.

Complaint.—Pain in left instep. Stiffness. Injured ankle twenty-four years ago. For one year he has had pain and swelling in the left ankle.

Physical examination.—Well-developed and nourished man. Pale. Left foot guarded in all motions by spasm. Considerable puffiness about ankle, bulging above os calcis. Tenderness about ankle. No redness. X-ray showed disease in and behind the tibio-tarsal joint. Operation advised.

September 28, 1903.—Tourniquet. Curved incision three cm. long behind inner malleolus extending forward one inch below this same bony landmark. Incision of fascia with escape of yellowish pus, clear and homogeneous. Incision prolonged. Near the anterior part of the astragalo-tibial joint the bone was soft. Cartilage entirely denuded. Necrotic bone extended to fibula. Long flexor of toes isolated and cut, stay suture in proximal end.

Tibialis posticus isolated and retracted upwards. Posterior tibial nerve retracted downward. Cavity curetted and rough places chiselled away. Disease in this part communicated with focus behind ankle. Flexor tendon sutured with mattress silk suture. Iodine used to swab out the field of operation. Fascia closed with silk over outer two-thirds; skin with interrupted silkworm gut; wick at post-



FIG. 97. Observe the thickening of the body of the os calcis and the location of the cavity on the plantar side of this bone about which there is considerable increase in the density.

erior end of incision into cavity behind ankle. Plaster from toes to knees with foot at right angle. Pus sterile.

October 15, 1903.—Discharged from Hospital in plaster.

Entered Hospital September 1, 1903, for the second time.

April 25, 1904.—The foot was manipulated under ether. Patient is able to bear weight.

May 11, 1904.—The condition in the ankle is improving. Patient was given plates and one-half inch cork heel.

August 1, 1904.—The patient has not improved to any marked degree the last three months, and cannot get the foot within 16°

of a right angle. Advised to enter the Hospital for osteotomy of the neck of the astragalus.

October 31, 1904. — Has been in the Hospital and had a wedge-shaped resection of the neck of the astragalus. Plaster removed. Dorsal flexion possible to from five to ten degrees beyond a right angle.

May 25, 1906. — Foot in excellent position. No pain. Is at work using the foot without discomfort and with very little limp.

**Case III.** M. S. Female. Age, 18 years. Entered the Carney Hospital April 7, 1902.

Ten years before entering this clinic she had tuberculosis of the tarsus for which she was treated conservatively. During this time she had two minor curettage operations.

On examination the right foot was plantar-flexed about ten degrees. Scars of old sinuses were noted on the outer and anterior aspects of the lower ankle. Very little motion was permitted, and the restriction was apparently due to a bony obstacle. It was thought that strain from the position of her foot was responsible for the symptoms, and for treatment a lift was put under the heel and a flat-foot plate was fitted to relieve the strain upon the foot.

April, 1903. — On account of the persistence of symptoms and occasional more acute attacks than she has previously shown, which evidently represents an exacerbation of disease and not joint strain, the patient was put into a plaster of Paris splint, which she wore the greater part of the year 1903.

April, 1904. — One of the old sinuses has been open for a month. "Bier treatment" applied and carried out for several weeks without effect. X-ray shows a focus of active disease in the astragalus and lower end of the tibia.

May, 1904. — Operation was undertaken for the removal of the disease from the astragalus and the tibia.

December, 1906. — Since the operation in May, 1904, there has been no recurrence of active symptoms in the ankle. The sinuses have remained permanently closed and the patient's general condi-

tion is excellent. She has however from time to time suffered from joint strain, these attacks invariably following unusual exertion. Osteotomy advised to correct the  $20^{\circ}$  of plantar-flexion which has persisted since the disease originally developed.

January, 1907. — Trendelenberg supra-malleolar osteotomy performed, and position of foot changed so that it is now at a right angle with the leg.

**Case IV. J. P. Female. Age, 17 years.**

Entered the Clinic March 18, 1901. States that she was treated for a tumor albus twelve years ago at the Boston Children's Hospital. Nine months ago she fell, injuring the same knee and was in the Boston City Hospital for a month and has worn a ham splint ever since.

Examination. — The right knee shows swelling over the inner aspect of the joint. There are  $35^{\circ}$  of motion in flexion; two inches atrophy of the thigh and calf; redness, increase of surface temperature. Leather leg splint applied.

November 4, 1901. — Signs in the knee are more acute; extension is complete; flexion possible to 25 degrees; swelling and tenderness over the inner side of the lower part of the femur. Operation advised.

December, 1901. — Physical examination. — Healthy appearance. Left knee swollen, particularly above joint and to inner side, where there is an area of redness. Over upper end of Hunter's canal is a fluctuating area size of a dollar. Around this the tissue is boggy and infiltrated. Some capsular thickening. 25–30 degrees of motion. Much spasm. Slight atrophy of calf and thigh. X-ray shows destruction of the external condyle of femur and tibia. (Figure 98 a.)

Operation. — Semilunar incision with apex about one cm. below patella. Capsule, especially lower part, much thickened and covered with tubercular granulations. External condyle of femur has practically disappeared, except two small protuberances, which were not the seat of active disease, but represented sequestra which

were not however detached. Synovial membrane dissected away. Bony protuberances removed. Process curetted from external condyle of tibia. Patella tendon sutured with catgut; capsule with



FIG. 98. Fig. (a) before operation. Extensive disease of the external femoral and tibial condyle. Internal condyles show no cartilaginous erosion. Note the knock knee. Fig. (b) after excision of the external and internal condyles. No increase in the knock knee. Patient has motion to 25 or 30 degrees and an excellent functional result.

catgut; skin with silkworm gut; small wick. Abscess on thigh opened with escape of considerable tubercular pus. Wicked with provisional suture. Posterior wire splint.

December 11, 1901. — Discharged from Hospital.

An X-ray taken two years after the arthrotomy (Figure 98 *b*) shows the post-operative condition at that time.

October 24, 1902. — Has visited the clinic regularly at intervals since the operation. Since the arthrotomy a genu valgum has developed; patella is free; there is no permanent flexion, and about 20° of free motion is possible. Sinuses have entirely healed. Wearing a leather leg splint.

December 2, 1903. — During the past year has worn the splint continuously, and has had no acute symptoms. Physical examination shows the same condition as under date of October 24th. Leg splint to be omitted one hour per day, increasing the interval in which she omits the splint gradually.

October 22, 1906. — During the past three years has been employed as a nurse-girl and has been able to do her work without interruption on account of joint strain or exacerbation of the old disease until the summer of 1906, when she injured the knee in some way of which she is not conscious, but ever since which there has been more or less discomfort of the character usually seen in joint strain. There is no evidence of an acute exacerbation. The knock knee is quite marked and is evidently responsible for the symptoms. Osteotomy advised.

January 31, 1907. — It is now eleven weeks since the osteotomy. Deformity corrected. Union is firm; motion is as yet not as much as before the operation. Advised to omit plaster and wear only a flannel bandage.

**Case V.** R. F. D. Male. Age, 37 years.<sup>1</sup> Occupation — Teamster.

October 28, 1902. Entered the Hospital.

Thirty years ago patient was in the Children's Hospital with what appeared to be hip disease on the left side. An abscess was opened in the thigh, and after being in bed for six months he was allowed to be up and used crutches for another six months. After that he could get about nearly as well as ever, and as well as any

<sup>1</sup> Reported in *Boston Medical and Surgical Journal*, August, 1908.

boy with whom he grew up. Is very positive that the hip was not stiff. Has been able to walk for nearly thirty years without the slightest difficulty. Eight weeks ago after a slight wrench sustained while at his work he began to have pain in his left groin. For this trouble he was referred to the City Hospital, and it was decided there after examination and the application of the X-ray for diagnostic purposes that the hip joint was not diseased. He was kept in bed for a few days while under observation there and was then referred to the Carney Hospital. He has no pain when he is at rest, but when he walks he has considerable pain referred to the left side and to the hip. Walks with considerable difficulty and is entirely incapacitated from his work. Patient has a sister who has had Pott's Disease and also tuberculosis of the hip. Otherwise the family history appears to be negative.

Physical examination — Well-developed and nourished man; good color. Thirty-five degrees of permanent flexion of the left hip. Motions are guarded by spasm. One and one-half inches atrophy of the left thigh; three-fourths inch atrophy of the left calf; no real or apparent shortening of the left leg. Very marked spasm of the psoas muscle. Internal rotation limited about two-thirds. About ten degrees of motion in flexion permitted. No abduction or outward rotation allowed. Trochanter very much thickened. Condition suggested a trochanteric process, unquestionably tuberculous.

An X-ray taken at the time indicated that the focus of the disease was in the greater trochanter.

Recommended to the House for operation.

November, 1902. — Focus of disease in greater trochanter excised. In House 4 weeks.

April 17, 1903. — Wound has remained entirely healed. The restriction in motion is about the same as before the operation. X-ray taken at this time shows no active disease.

March 28, 1904. — Spent the winter of 1903-04 at the Long Island Hospital, where he was sent because of an acute condition which developed in the left hip. The disease evidently extended from the



trochanteric focus up the neck of the femur to the head of the bone, and consequently an excision of the hip was performed at the Long Island Hospital. There are now only a few degrees of motion, considerable shortening, and a markedly everted foot with a discharging sinus. *Tendo Achillis* is much contracted.

October 23, 1905. — General condition has failed materially. Patient is rather hectic. No motion in the hip joint. About twenty degrees of permanent adduction. Profuse discharge from the sinus. Referred to Long Island. Could not be accepted there and was sent to Tewksbury. After staying in Tewksbury a few months he returned to the Carney Hospital early in 1906. At that time his general condition had failed. There were numerous sinuses about the hip through which bare bone could be felt, and from which there poured a profuse discharge. The iliac bone when palpated from the pelvic side seemed markedly thickened, and the evidence strongly pointed to the presence of a caries of the innominate, the head of the femur having been excised previously. An X-ray taken at this time also confirmed the other signs of innominate disease. Because of the grave condition to which the patient had been brought by his suppurative processes, though they had produced no evidence of amyloid in any of his internal viscera, and because it was extremely unlikely that the sinus would heal, and that a functional result of any value would be even remotely obtained by a longer continuance of conservatism, it was suggested to the patient that a radical attempt should be made to extirpate the disease by a formal excision of the innominate bone. To this the patient gave his consent, and an incision was made extending from the posterior superior spine of the ilium along the entire crest of that bone to a point immediately below the anterior superior spine; the muscles which were attached to it were dissected back from the outer surface of the bone down to the juncture of the ischium with the ilium. This was rendered comparatively easy by the fact that the head of the femur had been previously excised, though the cicatrix of the soft tissues about the joint and the suppurative changes which had been going on there for so long interfered considerably with the dissection. The muscles were

then divided from the pelvic side, great care being necessary to avoid coming in contact with the iliac vessels. The bone was eventually entirely denuded of its muscular attachments, the sciatic vessels and nerves were exposed, and pulled out of the way, and the innominate bone of the left side was separated from its fellow close to the symphysis and detached from its attachment to the sacrum. The wound had been packed with gauze, though there was comparatively little hæmorrhage, and for this was substituted several large cigarette wicks, which protruded through the skin incision in various places. The immediate shock from the operation was great, but the patient seemed to rally fairly well under saline injections subcutaneously administered and stimulation with strychnia and heat. He was fairly comfortable but did not make any gain in strength from day to day and gradually failed until the day of his death, the ninth day after operation. There was some suppuration in the wound but not enough to have accounted for his death apart from the shock.

The interest centering in the case was concerned particularly with the feasibility of excisions of the innominate for a disease of this bone. In the literature there have been a number of cases reported, principally by Koenig, in which the innominate has been excised, both for malignant disease and for tuberculosis. Four cases of tubercular disease of this bone have been operated upon in this way with one recovery. Nine cases of malignant disease (osteosarcoma) of the innominate have been operated upon with the same percentage of mortality.

**Case VI.** M. P. Female. Age, 30 years. Excision of head of humerus (total). Entered Hospital Orthopædic Clinic October 25, 1901.

For the past nine months patient has had pain and stiffness in the left shoulder, rendering it impossible for her to raise her left hand to her head. Patient's mother has been ill with phthisis and she has been her nurse, which has necessitated a great deal of lifting. Except for the possibility of the effect of this lifting upon her present

trouble, there has been no history of trauma. The joint has never been swollen or superficially inflamed. At first there was a great



FIG. 99. Tuberculous lesion of the shoulder. Observe the thick, squared, and somewhat elongated head of the humerus and the obscuration of the glenoid cavity by granulation tissue and erosion of the head of the humerus. Observe the relation of the head to the acromion process in this and in the post-operative cut of this same case.

deal of pain at night, but there is none at that time now. Considerable atrophy has taken place. She has been under treatment for a peri-arthritis of the shoulder, and the joint has been manipulated

with a view to breaking up adhesions. After this there has been more sensitiveness than before the manipulation.

Family history. — There has been a bad family history of tuberculosis, her mother having died of it and two brothers are ill with it.

Physical examination. — Well-developed and nourished woman. Left shoulder is held rigidly by muscular spasm and patient cannot move it in any direction voluntarily. Passively a few degrees of motion are possible. Rotation is entirely restricted and every attempt at motion causes pain. Very marked atrophy of the muscles of the shoulder and arm, particularly the deltoid. Heart and lungs negative. Patient has good color, and general condition seems excellent.

X-ray shows an extensive erosion of the head of the humerus and the glenoid seems to be filled up with detritus.

December 4, 1901. — Operation under ether. A five-inch incision was made parallel with the outer border of the bicipital groove, and one-half an inch to its outer side; capsule of the joint was opened by separating the outer fibres of the deltoid and dividing the fibrous covering. Head of the humerus removed after being severed by a Gigli saw, the saw cut being made immediately below the greater tuberosity. The inferior and anterior portions of the capsule were much thickened and lined with a tuberculous granulation tissue which extended over and covered the entire floor of the glenoid. When this was dissected out the cartilage showed only very superficial erosion. Cavity was sponged out with Iodine and a sterile wick left in for forty-eight hours, at the end of which time it was taken out and provisional sutures tied. A few catgut ties were necessary to control the bleeding and two silk sutures were buried to hold the separated fibres of the deltoid in approximation.

Histological examination showed tuberculosis.

December 18, 1901. — Patient returns to the Out Patient Department after excision of the shoulder. Has voluntary motion of the arm through about fifteen degrees; passive motions through an arc which is nearly normal. No evidence of acute disease. To have gentle massage and passive motion.

January 20, 1902. — Arm can be extended completely by the patient when the hand is supported. Hand can be placed upon the head with the aid of the other arm.



FIG. 100. Same as Figure 99, after a formal and complete excision of the head of the humerus. The functional result is excellent.

June 25, 1902. — Motion is slightly improved; has no pain; arm tires easily.

October 24, 1902. — Patient is able to feed herself, comb her

hair; no local recurrence; in excellent general condition; discontinuing passive motion and massage.

December 12, 1906. — Patient returned for treatment of other conditions. Passive motions of the shoulder can be accomplished through the normal arc in every direction. On active motion the patient can elevate the arm horizontally to within about fifteen degrees of a right angle with the trunk. When the elbow is raised upon a table she can perform any of the motions with her forearm and hand that she can with the other. She can hook her skirts behind with the left hand and can feed herself with the left hand. She does all the housework for a family of twelve and finds no difficulty in doing it so far as her arm is concerned. Her general condition is excellent, and except for the atrophy and shortening of the arm there is nothing abnormal in its appearance.

Since the patient was operated upon, her two brothers, who were ill with tuberculosis at that time, have died.

**Case VII.** F. C. Female. Age, 20 years. Entered Orthopædic Clinic of the Hospital, October 23, 1901.

When patient was a small child she met with an accident to the right shoulder which was said to have been a dislocation. Ever since she has had occasional trouble with the joint, but a week ago she noticed pain and some swelling in the region of the acromion process, and this condition, particularly the pain, has increased ever since, especially when attempts to move the joint are made. Patient has also had hip disease since she was three years of age and has used crutches until three years ago. The hip now gives her no trouble.

**Family history.** — Has a very bad family history of tuberculosis, the patient's mother and aunt having had large families of children, thirteen in both families, nine of whom have had tuberculous lesions in some part of the body, some of them joint, some of them pulmonary. Patient's only brother, who is four years older than herself, has tuberculosis of the knee and tuberculosis of the first phalangeal articulation of his right great toe, for which he has had an excision

of the knee joint and an amputation of the great toe. Patient herself has had some cough and positive signs of pulmonary tuberculosis. She also has a younger sister with marked tubercular glands and a condition in the chest suggesting an incipient tubercular process.

Physical examination. — Fairly well-developed and nourished girl; rather anæmic; walks with marked limp; has considerable shortening of the left leg, necessitating the use of a high sole. The left hip is ankylosed in a position of about thirty degrees of permanent flexion. The right shoulder is held rigidly by muscular spasm; from one-fourth to three-eighths of an inch atrophy of the right arm and forearm. Slight increase in the surface temperature over the shoulder joint and some tenderness on palpation.

X-ray (vide Figure 101) shows undoubted evidence of tubercular disease of the greater tuberosity of the humerus, involving to some extent the glenoid cavity.

Recommended to the House for operation.

October 30, 1901. — Operation under ether. Incision parallel with the anterior border of the deltoid exposed the capsule of the joint. An area of necrotic bone was laid bare which had infiltrated the greater portion of the tuberosity and extended to about one-fourth of an inch below the rim of the glenoid. Joint was opened. Cavity swabbed out with Tincture of Iodine. Wound closed with silkworm gut, leaving a small gauze wick. Sterile dressing. Shoulder spica with double sling. Discharged on November 6th, wound having healed by first intention.

November 8, 1901. — Patient returned to the Out-Patient Department after her operation. Wound entirely healed, and from this time on during the remainder of the year 1901 the convalescence was uneventful.

January 15, 1902. — Patient is able to use the arm enough to feed herself, but cannot dress her hair. No signs of acute trouble. Wound closed solidly. Has had some cough and expectoration, but no tubercle bacilli were found in the sputum. Encouraged to use the arm more, and given tonic treatment.

November 12, 1904. — A small sinus has developed in the lower portion of the cicatrix, from which a thick creamy pus was discharging. Motions of the shoulder fairly good. Under creolin



FIG. 101. Cf. with Figure 99. Note the rarefaction of the greater tuberosity of the humerus and the comparative freedom of the anatomical neck and head of the humerus from disuse. The line of demarcation between the glenoid and the head is clearly shown. At operation pus was found in the greater tuberosity. This prominence was excised and the head was not disturbed though the joint was opened. Functional result not greatly better than in Case VI.

dressing the wound eventually closed, and patient was not seen again until the 30th of March, 1903, on which date it was thought



that the scar tissue was a factor in restricting the motion of the joint, especially the outward rotation. Advised to continue free use of the arm and to have some passive motions to stretch the scar.

December 7, 1904. — At this time the shoulder wound was entirely healed and about two-thirds of the normal motions of the shoulder were preserved in all directions.

January, 1907. — Patient is in excellent general condition. Is engaged in a clerical capacity in a business house. Dresses and feeds herself without inconvenience from her partially excised shoulder. Has about one-half the normal motion in the joint.



FIG. 102. Note the line of fracture through the humerus just above the condyles. All outline of the elbow joint has been obliterated by the old tuberculous process.

**Case VIII.** H. M. Female. Age, 28 years. March 29, 1902.

When two years of age had trouble with hip, elbow, and spine, supposed to be due to measles. An abscess formed at elbow, which discharged for one year. No abscess at hip or spine.

The right elbow has remained flexed at an acute angle for many years without motion until three weeks ago. Then fell, striking right elbow. Since then arm has been held at a right angle, and to-day

there is about  $10^{\circ}$  of motion with some grating. General health seems good. Very little swelling about elbow, and no marked tenderness. Flannel bandage.

X-ray taken (Figure 102) showed fracture, which accounted for the change in position and the grating. Because of the proximity of the fracture to the joint it seemed likely that an excision would give her a more useful arm than ankylosis in the best position possible at that time. Excision was accordingly performed early in June, 1902.



FIG. 103. Same case as that shown in Figure 102 after excision of elbow joint.

Except for some lateral displacement of the radius and ulna upon the humerus, necessitating the use of a jointed leather splint, the result has been satisfactory and the motions are well shown in the accompanying photographs. (Vide Figures 104 and 105.)

**Case IX.** Mr. A. Age, 39 years. (Figure 106.)

The patient has been under treatment for pain, lameness, and finally total disability for eight months, the last six weeks of which he spent in a hospital. The symptoms were referred to his left hip



FIG. 104.



FIG. 105.

FIGS. 104 and 105. These cuts show the amount of voluntary flexion and extension this case possessed after excision of the elbow joint.

and knee. His general condition had steadily failed. When first seen the thigh was completely extended, outwardly rotated, and adducted about  $20^{\circ}$ . There was no motion permitted at the hip

joint and muscle spasm was marked. The thigh and calf were considerably atrophied. There was very little actual but a good deal of apparent shortening. All attempted motions of the left thigh were very painful. The man was anæmic and poorly nourished. His



FIG. 106. Tuberculous disease of the head of the femur. Excision. Note the osteoporosis of the head and neck, the obliteration of the line between the acetabulum and the head of the femur. Observe that the disease was apparently oldest in the inferior border of the femoral head.

temperature was somewhat elevated every evening. There were no signs of tuberculosis in his chest.

He was put upon traction to quiet his pain and an attempt was made to build up his general condition preparatory to an excision. At the end of two weeks of bed treatment the head of the femur was excised through a posterior incision. There was extensive capsular

disease and the cartilage over the femoral head was loose, though in place. There was some pus in the joint. He was kept in the hospital about four weeks and was discharged in a plaster spica. The general condition improved, the sinus following the operation closed,



FIG. 107. Tuberculous disease of the carpus, with extensive involvement of the tendon sheaths on the dorsal and palmar surfaces of the wrist. The disease was more active toward the metacarpals than toward the forearm.

and six months after the operation the patient was reported as being in fairly good condition and getting about on his crutches.

**Case X.** J. B. Male. Age, 33 years. November, 1901.

Patient has had trouble with his right wrist for  $2\frac{1}{2}$  years. The first thing noticed was swelling of the palm of the hand and a feeling

of itching in this region. Pain came on shortly after this, sometimes quite severely. Case was operated upon in July, 1901, by the family physician and a number of rice bodies removed from the palm. A second operation was performed in August of that same year with similar findings. Patient is a janitor, and has been obliged to use his hands a good deal at hard work. Of late the strength in the hands has materially diminished and he has very little grip at the present time. The swelling is extending to the dorsum of the wrist.

On physical examination there was marked swelling of the right wrist posteriorly above the malleolar ligament and anteriorly from the middle of the palm well above the malleolar ligament. Two or three hard masses are to be felt in the palm of the hand, apparently connected with the tendons. There is very little power in flexion of the fingers and in the index finger as well as the middle and ring fingers there is considerable restriction in motion.

An X-ray showed extensive disease of the carpal bones (Figure 107), and an excision of the wrist was performed, the greater part of the carpal bones, especially the anterior row, being removed. The results of this procedure are seen in Figure 108.

After the operation the convalescence was uneventful, except for the development of a cold abscess about six months after this first operation. This had to be drained. Subsequently the sinus entirely healed and at the end of a year the patient was doing his former work, protected by a leather splint to the forearm and wrist. The functional result has been very satisfactory.

**Case XI.** Mrs. N. N. Age, 47 years. November, 1902.

Patient has always been well except for a probable attack of appendicitis three years ago. She has also been somewhat troubled by a chronic bronchial affection in the winters. The family history is negative as regards tuberculosis or other chronic diseases.

About three years ago she first noticed some swelling and discomfort of the right foot. On removing the shoe she found that the foot and ankle were somewhat swollen. After a night's rest this swelling disappeared, but recurred off and on during the succeeding two

years, especially after any considerable use of the foot. She has gained considerably in weight, which has made walking more difficult. About nine months ago she had a quite serious attack of this same pain, which kept her in bed for some time and the swelling then manifested itself on the inner side and the anterior surface of



FIG. 108. Post-operative view of Case x. Observe the few remnants of the carpal bones and the shortening up of the wrist.

the ankle. Since that time she has been obliged to use crutches, and has had a good deal of pain most of the time, frequently being kept awake at night in consequence of this. There has been a good deal of spasmodic muscular contracture in the foot. During the past

three weeks the foot has been protected by a silk elastic anklet, which has given her some relief. Her general condition seems to be good.

On physical examination the right ankle was diffusely swollen about both malleoli, the swelling extending well to the front of the ankle. On deep palpation there was a good deal of sensitiveness, especially over the internal malleolus. The foot is held in a position of plantar-flexion and can be brought to nearly a right angle. Inversion of the foot is the most painful of all motions and gives rise to a good deal of muscular spasm. Surface temperature over this

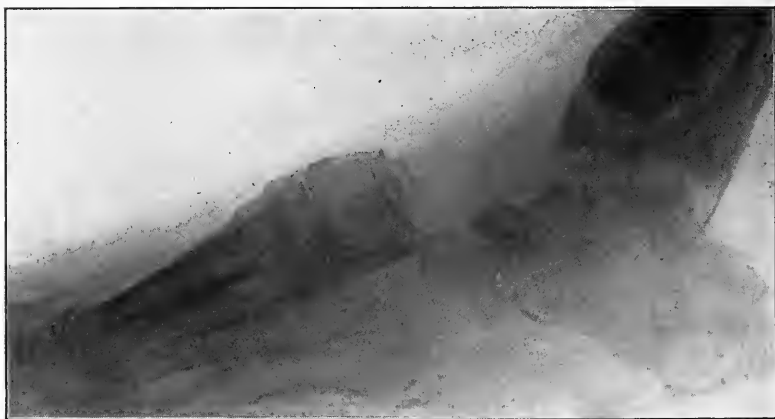


FIG. 109. Cf. with Figure 92. Extensive disease of the tarsus, the entire astragalus being removed. Disease entirely cured but function poor. Observe the osteoporosis particularly of the os calcis.

region considerably increased. One inch of atrophy of the calf. Patient was protected in plaster for some time. An X-ray showed extensive tuberculous disease of the astragalo-scaploid and astragalo-tibial articulations, but no definite bone focus could be demonstrated.

Patient was exposed to the X-ray for treatment a number of times, but without any material effect.

The condition did not improve under conservative treatment, and on January 14, 1903, patient was operated upon, and extensive tuberculous disease was found in the soft parts traceable to the foci



above mentioned. There was also a small focus in the internal cuneiform bone. The disease was thoroughly dissected out and dry dressing and plaster of Paris splint put on.

At a subsequent operation the astragalus was removed, and after this operation the symptoms which were attributable to the disease ceased.

The patient eventually became able to walk about with the aid of crutches and a protective splint to the ankle, but on account of her weight it was impossible for her to walk upon the foot unsupported by apparatus. The disease has remained cured ever since the last operation. The extent to which the tarsal bones were removed at the operation is indicated in the accompanying Figure 109.

## CHAPTER VIII

### THE OPERATIVE TECHNIQUE AND MECHANICAL TREATMENT OF TUBERCULOUS JOINT DISEASE

IN the previous chapter the indications for the employment of operative measures in the treatment of joint tuberculosis have been carefully considered. In this chapter we shall describe the details of the methods which have been found satisfactory in our hands in the management of these lesions.

#### *THE HIP*

**Arthrotomy** of the hip joint is occasionally performed for diagnosis, and has been resorted to for the purpose of removing localized foci in the head of the femur. An anterior incision is best for this purpose and should be made over the front of the joint at a point about halfway between the anterior superior spine and the greater trochanter, the centre of the incision being over the neck of the femur. The muscles of the front of the thigh run more or less parallel to the skin incision and can be separated in this line until those are reached which are inserted into the capsule. These must then be separated in the direction of their fibres, which will be at right angles to the skin incision. This brings one down to the capsule, which is then incised, parallel with the long axis of the neck. If the skin incision is long enough retractors can then be inserted and the neck and head of the femur and the superior lip of the acetabulum may be exposed. By rotating the thigh a considerable portion of the articular cartilage of the head of the femur may be brought into view, superficially located lesions may be excised and considerable portions of the synovial capsule dissected out. The joint should be swabbed with Iodine and then closed, with suitable provision for drainage, preferably a cigarette wick.

Sutures to the capsule are not necessary, but deep, loosely tied, catgut sutures through the muscle are desirable except at the place where drainage is to be left. A cigarette wick inserted to the bottom of the cavity of the joint is advantageous in all hip operations, however aseptically carried out. Protection of the hip joint after erosion is quite as necessary as it is in the treatment of tuberculous disease of this articulation when no operative measures have been practised. Failure to observe this caution has doubtless been responsible for many of the poor results following operations upon the head of the femur. A plaster spica should be worn for a few months after operation and weight-bearing should be prohibited until all sensitiveness of the joint has ceased and firm cicatrization has taken place. A long Dessault side splint, accompanied by light traction is desirable while the patient is in bed. Care should be taken to prevent outward rotation of the limb and in all cases where actual shortening exists or seems imminent a position of moderate abduction (20 degrees) is indicated. The amount of sensitiveness should be the guide to the beginning of weight-bearing and passive manipulation. Motion after an arthrotomy of the hip is difficult to secure; a promise of normal motion should never be made.

**Excision.** The best route for excision of the femoral head is through the posterior or Langenbeck incision. (Figure 110.) A long cut slightly curved posteriorly, commencing well above the top of the trochanter and carried down the thigh in such a way as to clear the posterior edge of the greater trochanter will make it possible to gain access to the joint capsule without traversing much muscular tissue. The attachment of the short rotator group of muscles should be severed from the trochanter and after this an assistant should rotate the thigh inward. If the incision in the capsule is long enough the head of the femur may be delivered through this incision and the neck of the bone may be divided with a saw, close to the head or as remote from it as may seem necessary. A cigarette drain should be inserted into the angle of the wound to provide for the escape of the exudate which invariably accumulates after surgical procedures of such severity as those which have been

described. This should be retained for forty-eight hours at least and the incision may then be closed by a suture which has been

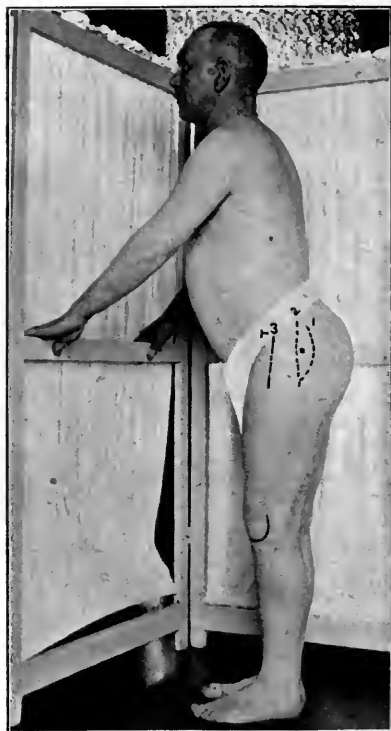


FIG. 110. (1) Indicates the incision employed by Langenbeck in excising the head of the femur. (2) Indicates the lateral incision sometimes used. (3) Is the line of incision employed when the joint is opened from the front. The (T) indicates the anterior superior spine.

provisionally placed or any remaining exudate may be allowed to escape along the path of the wick, the skin incision not being completely closed. Very little hæmorrhage occurs in either of these operations. It is rarely necessary to tie any vessels. Drainage in non-suppurative cases should be continued for from 48 to 72 hours. In suppurative cases drainage should be kept up until the sinus has become well established, which generally requires ten days or two weeks, depending somewhat upon the amount and freedom of discharge. As much of the soft parts of the capsule should be removed as seems diseased, or can be reached through such an incision. It is important in the belief of the writers to remove whatever provisions have been made

for drainage in these operative cases as early as possible and encourage the closure of the sinus even though it may subsequently spontaneously open. It is also sometimes possible to remove diseased portions of the acetabulum, and provide drainage for caries of that bone.

Iodine should be freely applied to the tuberculous granulations remaining on the capsule after incision. This does not interfere

with healing and seems to be hostile to tuberculous infection. The writers have witnessed no bad effects from absorption of Iodine so used.

Traction for the purpose of steadying the femur after excision is beneficial and until the patient is permitted to be up a completely fixative dressing is not necessary. Recumbency after excision should be more prolonged than after a simple arthrotomy and should continue from four to six weeks, preferably the latter. A more or less unstable joint is inevitable and there will be from two to three inches shortening of the leg. Crutches or a cane and apparatus as a permanent aid to walking may be necessary. It is important that the position in which the femur is left after an excision should be one which is favorable for weight-bearing and consequently the use of a spica should be a routine part of the post-operative treatment. The spica should be applied with the leg in a position of abduction and slight outward rotation.

**Gant's osteotomy.** This is usually performed through a subcutaneous incision made by the osteotome. (Figure 111.) The instrument should be driven to the bone parallel to the long axis of the femur and at a point immediately below the level where the greater trochanter is joined to the shaft of the femur. When the bone is reached the osteotome should be turned one-half around so that its cutting surface lies at right angles to the long



FIG. 111. Indicates the landmarks to be observed in performing Gant's osteotomy. The upper and more anterior mark is the anterior superior spine; the dotted cross represents the line of the skin and osseous incisions respectively; and the dot indicates the top of the greater trochanter. This patient had hip disease and the femur was dislocated.

axis of the femur; the bone should then be divided without removing the instrument from the incision in the femur. Division of the bone should be gone about systematically, the edge of the osteotome being so placed upon the side of the femur that it will cut the cortical bone throughout its entire anterior convexity to the depth that may seem desirable and then it should be brought still further over the outer side of the femur and again driven through to the same depth and yet again still further removed to the outside and the section of the bone carried across its entire outer aspect.

The operator relies both upon his sense of hearing and feeling in performing this operation in the manner described. After he has satisfied himself that the entire breadth of the bone has been divided to a sufficient depth then the osteotome may be removed and the fracture completed manually. In doing this the force should be applied steadily and gently in a direction which will tend to open the osseous incision wider than the instrument has done. When the operator receives evidence that the femur has yielded then the force should be applied in the opposite direction in an attempt to secure an impaction of the outer portions of the line of fracture. The limb should then be put up in a long plaster spica. This should include the trunk and extend to the toes. It should be applied in a position of from 20 to 25 degrees of abduction; in case there is actual shortening there should also be about 15 degrees of permanent flexion. In this position the patient can sit quite naturally in a chair. During the operation the patient should lie on the sound hip and the only instruments which are absolutely necessary are an osteotome and a mallet. No sutures are necessary. An open incision is occasionally of advantage.

The length of convalescence in bed should be determined by the comfort of the patient and the ease with which he can move himself. At least three or four weeks is necessary. After that, if the patient elects, he can try getting up and about on crutches. Twelve to fourteen weeks must be allowed for union. After six or seven weeks have elapsed the plaster may be shortened at the waist and the foot portion of the splint may be removed, thus allowing more freedom.

*THE KNEE*

**Erasion.** It is sometimes feasible to remove tuberculous disease from the knee joint by means of an operation commonly called "erosion." This does not contemplate a removal of any part of the bones of the femur or tibia, but consists of a thorough dissection of the synovial membrane of the knee joint and its bursal connections and the removal of such an amount of the cartilage covering the ends of the femur and tibia as is necessary to expose the cancellated bone beneath. After this has been done apposition of these raw, bony surfaces will result in their fusion without the production of so much shortening as necessarily follows a formal excision. To accomplish this purpose an incision through the skin and soft parts similar to that which is described below under the operation of "Excision" has been found most satisfactory.

**Excision.** A long U-shaped incision through the soft parts exposes the joint freely. (Vide Figures 112, 113.) It is easier to perform this operation with a tourniquet, but it is not absolutely necessary to use it. The closed end of the U-shaped incision should be just above the tibial tubercle, and the arms of the U should extend up the sides of the knee joint to points opposite the top of the quadriceps bursa. If the tourniquet is not used a number of bleeders will be encountered when the incision in the capsule is made. The patellar tendon is divided at about its mid-point, and the portion of this attached to the patella affords a good hold for a tenaculum by which the patella and the capsular flap may be turned back. It is convenient to replace the skin and capsular flap together. The next step consists in a dissection of the diseased portions of the synovial membrane, devoting particular attention to the openings of the various bursæ into the joint. Having determined from the extent of the disease how much of the femoral and tibial condyles it is desirable to remove, the knee should be flexed to a right angle, and a careful section of the two bones should be made with a saw. The surfaces may be convexed on the femur and concaved on the tibia, but this is difficult to do accurately and no special advantage

accrues. Care must be exercised to make the saw cuts in the same plane so that when the bones are again approximated they may be brought together accurately. After the removal of the bone sections, an opportunity is offered to approach the posterior portion of the capsule of the joint, and dissect out diseased tissue. The cavity of the joint should then be thoroughly treated with Tinc-



FIG. 112.



FIG. 113.

FIGS. 112 and 113. Figure 112 indicates the other arm of the U-shaped incision employed in excision of the knee. Figure 113 shows this incision from the front. Observe particularly the extent to which it comes down upon the tibia. In Figure 113 is also shown on the left knee the incisions employed to reach the semilunar cartilage (the posterior of the two), while the anterior gives access to the fringes which it may be desirable to remove. Foreign bodies may be reached by going through the popliteal space when they are located in the posterior portion of the capsule.

ture of Iodine. No metallic bone sutures are necessary. The leg should now be extended, the tourniquet loosened, and any considerable bleeders tied. The removal of the patella is usually desirable though it is not always involved in the tuberculous process. The patellar tendon should be united with chromocized catgut or silk where the patella is left, and the bone or capsule held by from four to six sutures of the same material. Wicks should be inserted



in the angles of the wound for forty-eight hours, and the skin closed with interrupted silkworm gut. In case the disease has not involved the patella, its cartilage may be removed and a depression made on top of the tibia and femur into which it may be fitted. This is of cosmetic value chiefly. Dry sterile dressings and either a posterior wire or a plaster of Paris splint including the toes and terminating at the perineum should be employed. Five degrees of flexion is a rather better position than one of complete extension. If the posterior wire splint is used it may be omitted after the second or third week, and plaster of Paris substituted. Union is generally firm enough at the end of three or four weeks, so that the patient can be gotten up, and in a couple of weeks more, crutches being provided, he can walk without weight-bearing. It is well to remove the plaster at the eighth week, test the stability of union, and apply a new plaster. If union is fairly firm, partial weight-bearing may be allowed during the tenth week, and gradually increased. Between the twelfth and fourteenth week the plaster may be removed altogether in most cases and union will be solid. Failure to unite, in the authors' experience, has been due to a failure to remove enough of the diseased parts. In three cases secondary operations have been performed in such cases, active disease found and removed, after which union has then gone on to completion.

### THE ELBOW

**Excision.** It is rare that tuberculous disease of the elbow joint can be extirpated without the performance of a formal excision. Experience in the operative treatment of various conditions in or about this articulation has demonstrated the difficulties of securing satisfactory function after partial excisions of the bones. The reason for this is the complexity of the trochlear surfaces of the humerus, ulna and radius, and the closeness with which the capsule fits. As a result of fractures of the external or internal condyle of the humerus, removal or even replacement of the injured condyle is at times possible with the preservation of fairly good

motion. When formal excision is practised, the median, posterior incision is best. An incision about 10 cm. in length, half of which is over the lower end of the humerus, and half over the upper end of the ulna, exposes the joint well. The attachment of the triceps to the fascial expansions over the upper portion of the ulna must be preserved. With a blunt dissector or periosteum elevator the fascia should be pushed away from both humeral condyles, and from the olecranon process of the ulna. After this has been accomplished a saw can be inserted and the condylar surfaces excised. With the elbow flexed, it is not now difficult to push the upper ends of the radius and ulna into the wound where they can be reached. It is desirable to turn in a flap of fascia or fat obtained from the neighboring tissues. The deep structures should be sutured with interrupted catgut sutures, and the skin with silk-worm gut. The arm should be put up on an internal angular splint, and kept there for from two to three weeks. A soft dressing may then be substituted, and gentle passive and active motion permitted. In two months fairly good functional use may be expected. In some cases there will be too much lateral motion at the false joint, rendering the articulation more or less unstable. To control this a jointed leather splint permitting flexion and extension, but holding the ends of the humerus and ulna together so that they cannot slip past each other laterally, has been employed.

### *THE SHOULDER*

**Excision, Arthrotomy.** The removal of the whole or a part of the head of the humerus may be accomplished through an incision parallel to the direction of the bicipital groove and a little to the outside of it. The patient should be recumbent with the hand in a position halfway between pronation and supination. The skin incision should be from 6 to 8 cm. in length, and the capsule of the joint will be exposed by separating and retracting the fibres of the deltoid. The subacromial bursa will be encountered immediately over the capsule of the joint, and the subdeltoid portion of it

may be removed through this incision when its removal is indicated. (Figure 114.) In cases where the disease has not invaded the joint, but is chiefly located in the greater tuberosity of the humerus, it is not necessary to go further toward the joint, but the focus may be resected without opening the articulation. In case the head of the humerus or the glenoid are so involved as to make the removal of the head of the bone a matter of necessity, this can be readily accomplished. Closure of the capsule and skin, with provision for temporary drainage and fixation with a double sling or Velpeau bandage, completes the operation. Confinement to bed for more than two or three days is not necessary. If there is no involvement of the glenoid, manipulation, gently carried out, may be practised after the third or fourth week, and moderate active use may be allowed.



FIG. 114. Incision for excision of the shoulder, or when shorter for reaching the subacromial bursa, particularly the subdeltoid portion of it.

### THE WRIST

**Excision.** Early excisions may often be limited to one or two bones, or to the distal or proximal row of carpal bones. Late excisions, that is, in those cases in which considerable involvement of the complicated synovial capsule has taken place, are better if made complete. A lateral incision involves very little likelihood of injury to vessels or nerves or annular ligament and enables one to dislocate the carpus upon the radius in such a way as to render it comparatively easy to enucleate the bones of the carpus. This incision is made over the radial side of the carpus. A posterior incision also gives very good access to the carpus and the extensor tendons are easily pulled to one side. Involvement of tendon sheaths may, or may not, complicate carpal disease. If it does and an extensive dissection of tendon sheaths is necessary, amputation is a better

operation because of the liability of recurrence after conservative, operative treatment. A palmar splint, or plaster of Paris should be worn for from four to six weeks before use is permitted.

### THE ANKLE JOINT AND TARSUS

**Arthrotomy. Excision.** The most practical method of getting at the ankle joint is through a disarticulation. A semilunar incision, commenced just behind the external malleolus and over the sheath of the peroneal tendons, is carried below the malleolus and well up on the dorsum of the instep. (Figure 115.) It is much easier to perform this operation when a tourniquet is applied. The peroneal tendons should be divided below the external malleolus and the ends caught with sutures so that they may later be reunited. The peroneus tertius and outer fasciculi of the common extensor may be pushed to one side. When the capsule is opened the foot may be forcibly twisted toward the inside and the inferior surface of the tibia, the articular surface of the malleoli, the trochlear surfaces of the astragalus, the os calcis and the proximal articulations of the medio-tarsal joints will be exposed. This incision gives opportunity for a thorough dissection of the capsule of the ankle joint proper, and some of the smaller though independent articulations. Through it also the tarsal bones nearest the ankle joint may be excised. In order to get at the mid-tarsus when the ankle joint is not involved it is not necessary to dis-



FIG. 115. Incision through which the ankle joint may be exposed after retracting or dividing the peroneal tendons and dislocating the tibia and fibula outward.

articulate at the ankle, and short lateral incisions over the scaphoid on the inner side, and the cuboid on the outer will usually give ample access to the diseased regions. A thorough removal of all diseased bone, and dissection of synovial membrane followed by an Iodine swabbing completes the operation. Through and through drainage is frequently necessary. Very few ligatures are required, and the wounds may be sutured down closely upon the drainage. In some cases, drainage may be only temporary and provisional skin sutures are permissible. When the wounds are likely to discharge but little, and will remain open only a short time, the foot and leg may be put up in a fenestrated plaster, leaving the foot at right angles with the leg. After an arthrotomy, when there has been no removal of bone, six weeks to two months is about the average time required for convalescence. After excision of the tarsal bones, four to six months ought to expire before weight-bearing is attempted.

**Macewen's osteotomy.** Correction of the deformities which succeed tubercular lesions at the knee joint are best corrected by the osteotomy devised by Macewen.

This is a linear section of the femur just above the knee joint for the correction of flexion and knock-knee deformities at this articulation. It may be done without an open incision, the osteotome being driven through the skin parallel to the long axis of the femur, and about  $\frac{1}{2}$  to  $\frac{3}{4}$  of an inch above the adductor tubercle. (Figure 116.) The osteotome is then turned so that its cutting surface is at right angles to the long axis of the femur, and the bone is cut across its entire inner border to such a depth that the fracture can be completed manually by bending the bone outward in a direction opposite to that in which it is desired to complete the correction. When possible complete severance of the bone should be avoided, as it



FIG. 116. Incision for Macewen's osteotomy. This may be through an incision made directly opposite this point.

materially aids in the splinting of the fracture not to completely divide the bone. When the fracture is complete the fragments should be impacted. Occasionally a wedge-shaped osteotomy will

be required to correct either flexion or knock knee. This requires an open incision.

It is sometimes of advantage to perform the osteotomy from the concavity instead of from the convexity of the deformity in order to prevent the slight increase in actual shortening in usually already short limbs.

The osteotome is entered at the level of the adductor tubercle on the outer side. The bone is divided to the inner cortical layer and the deformity corrected by making a green stick of this same shell of bone cover. This leaves a slight gap between the bone edges of the osteotomy incision on the outer side. This gap readily fills in with new bone and represents a small amount of actual lengthening as an end result.

After the deformity has been overcome, the leg may be put up in plaster of Paris, extending from the perineum to the tips of the toes. No sutures are neces-



FIG. 117. This illustrates the position for the incision employed in performing a Trendelenberg osteotomy for correction of the deformity of flexion and eversion of the foot, particularly when these are dependent upon faulty positions after fractures. The horizontal line over the right ankle marks the tip of the malleolus and the vertical line indicates the point where the chisel should be inserted, its direction being changed to a right angle with this when the bone is reached.

sary, except in the open incision and therefore there is no necessity to inspect the wounds until it is time to take off the plaster. Firm union requires from ten to twelve weeks for its accomplishment,

though the patient may be allowed to bear some weight on the foot before that time with the aid of crutches.

**Trendelenberg's osteotomy.** This osteotomy is undertaken to overcome deformity at the ankle joint. It is generally performed at a point about  $1\frac{1}{2}$  inches above the front of the ankle joint. (Figure 117.) One short open incision, parallel with the long axis of the tibia and close to its outer border, will permit of the division of the bone through one incision. If the operator prefers, both bones may be divided through subcutaneous incisions, and then after correction of the deformity the leg and foot should be encased in plaster of Paris. Eight to ten weeks will be necessary to secure firm union after this fracture. Some cases may solidify a little earlier than that.

**Abscess.** The treatment of tuberculous abscesses by means of aspiration requires no special technique. The authors have had the most satisfactory results from the use of large-calibred trochars. Scrupulous surgical cleanliness must be observed both in the preparation of the field of operation, the instruments used, and the hands of the surgeon. No suction is necessary and the injection of chemical substances has not been found desirable. The wound should be sealed with an aseptic dressing. It is often the case that the abscess will refill within a day or so, and subsequent tapplings may be necessary. The method referred to elsewhere as Dr. Starr's method is the best to employ when an open operation has been decided upon. The incision should be through sound tissue, and after the pus, and, if possible, the diseased bone at the bottom of the process, have been cleaned out, and the wound should be closed layer by layer without drainage.





## SECTION II

### NON-TUBERCULOUS DISEASES OF THE JOINTS

#### INTRODUCTION

IN the study of chronic joint diseases, tuberculosis has always played a very important part; so important, in fact, that it has taken the surgeon a long time to distinguish between tuberculosis and other monarticular forms of arthritis pursuing a chronic course. Polyarticular joint affections, in virtue of their being polyarticular, are commonly regarded as rheumatic. Aside from these two large divisions, few other arthritides have been recognized and they only occasionally by those who have had particular advantages for observation. It will be our purpose, therefore, in this section to try and bring the results of recent study and observation, both clinical and pathological, to bear upon the older classifications, and attempt to clarify the confusion which has so long existed. A number of observers have been at work in different parts of the world and though in some details their results differ, yet, on the whole, the broad lines of the classification here used will be found to have been arrived at independently and almost contemporaneously by all who, whether approaching the subject from the pathologist's or clinician's point of view, have divested themselves of any prejudice peculiar to their particular calling and have studied the matter from the vantage-ground of an untrammelled judgement. A great advance toward the present way of looking at this subject was made when physicians first began to make physical examinations of patients who presented themselves with joint lesions. If these patients were not sick enough to compel them to go to bed and send for their doctor but merely called upon him at his office, he was very likely to put them off with the salicylates or the iodides and the admonition to

drink plenty of water. If they were sufficiently well off he sent them to "the springs." This method prevailed in private practice in the past, and does still to a lamentable degree. It was only natural that the same method should be pursued in the clinics, and consequently any opportunity to observe differences existing in types or the changes taking place during the course of the disease in the various joints was deliberately neglected by those whose opportunities for study were the greatest. The time has tardily arrived when patients with these chronic lesions can at least have as much studious attention given to their symptoms and the physical signs which are their basis as the subject of a pneumonic process or an obscure abdominal condition receives, if they present themselves at a private office or a public clinic. There would seem to be more reason for the practitioner to give, and for the patient to demand, this attention in the case of a chronic, progressive condition than if it were acute. Aside from the matter of the personal comfort of the individual there are other and weighty reasons for the awakening of interest in chronic joint disease. It is a question of economics of no slight moment, and not local, family economics, but economics touching the body politic. There is doubtless far greater loss to the individual, to the family, and to the state, as a result of the disabilities of chronic non-tuberculous joint disease than there is from any one of the ordinary acute infections from which mankind suffers. In this computation one must include the actual loss of time from complete though occasional "lay-offs," the diminished efficiency of those partially but continuously incapacitated, and the charge against local charity or the state for those totally incapacitated and those dependent to a greater or lesser extent upon them. Here, certainly, is abundant argument, if any were needed, to justify the organization of clinics where such subjects can be studied, the establishment of hospitals (not homes for incurables) where such patients can be treated and the institution of researches which will surely throw light upon the fundamental causes of the disease giving rise to those lesions, thereby helping to put us in a position where treatment can be devised which will be productive of more

satisfactory results than have attended what little real effort has been put forth in the past.

Upon the medical profession rests the onus of the present status of non-tuberculous joint disease. We have used none of the methods which we would have employed to study a disease which showed more response to treatment. We have denied sufferers from these diseases admission to hospitals, nominally because there were more urgent cases, but really because there were more interesting cases to be studied. We have provided most large communities with homes for the incurable, where they are beyond professional assistance, and more or less efficient nursing is all that there is to offer. The sporadic attempts which have been made in the past to understand these conditions a little better have been characterized by an occurrence similar to that which has prompted us to go on year after year without making a physical examination upon these patients and to provide them with retreats where there was no possibility of their being studied or treated, and but little, oftentimes, of their being made more comfortable than in an almshouse. The only place the would-be student of those conditions could pursue his studies has been in these same almshouses and homes for incurables. In acute diseases much can be learned, post mortem, concerning the causation and development of the disease under consideration. This is not so nearly true of chronic conditions, and yet this is the material from which conclusions have been drawn, — conclusions tending to discourage the further study of these conditions. The medical profession has no right to expect any results in the way of *treatment* when its study of the causes leading up to the disease and the changes which characterize it, both clinically and pathologically, have received so little of its scientific study and serious thought.

Any classification which is adopted must have as a basis differences in etiology, clinical manifestations, and morbid changes. There can be no other ground for a differentiation of diseased conditions. How have such standards been applied, when in places no farther apart than Germany and England the terms, "rheuma-

toid arthritis," "oste-arthritis," "rheumatic gout," and "arthritis deformans" mean the same thing! A nomenclature has been applied which sought to identify a chronic condition of the joints with a well-recognized acute affection to which it had some faintly suggestive resemblances, as in "rheumatoid" and "rheumatic gout," or sought to indicate graphically some characteristic which was more or less strikingly evident upon a cursory view of the affected joints as "arthritis deformans" and "oste-arthritis."

In order to have some starting-point from which to work, the classification used here will employ a nomenclature which expresses certain striking characteristics of the groups of symptoms which are being considered. It is open to the obvious objection that one term employed implies that the basis of the classification is etiology, while the other two would indicate that it was essentially clinical. Remembering that it is only a working hypothesis and that it is therefore liable to infinite change, it seems to offer a centre about which a considerable number of observations may be crystallized.

## CHAPTER I

### INFECTIOUS ARTHRITIS

UNDER the heading of Infectious Arthritis may be included all pathological processes in the joints which conform clinically or histologically to those diseases in which bacteria or their toxic products give rise to lesions elsewhere. In their consideration in this chapter an attempt has been made to separate them from those types of arthritis, the description of which is to follow, and which in the authors' view are produced by other agencies than infections.

Inflammations of joints in most instances may be traced to some infectious cause. The more acute the inflammation the more readily can the nature of the cause be inferred. The tissue changes produced are the result of the presence of organisms themselves or of the toxins manufactured by them. It is probable that most of the polyarticular inflammations are the result of toxins. Certainly demonstration of the organisms themselves is extremely difficult. The sources of toxin production may be very remote from the affected joints.

Certain of these infections are due to a systemic toxæmia, e. g., acute articular rheumatism; others, by far the larger number, are local infections accompanied by toxæmia, and do not produce severe constitutional symptoms, sometimes none at all. The fewer the joints involved the less evidence there is of systemic involvement; indeed in some of the monarticular cases there is nothing to be detected except the local signs of joint inflammation. In most instances it is impossible to demonstrate by indisputable scientific evidence the existence of organisms in the affected joints. This is probably due in part to the fact just noted, viz. — that many times toxæmias cause the joint manifestations, in part to the fact that some organisms are very short-lived or may be present in very

small numbers, thus escaping detection, and in part to a fact which has been cited in explanation, that an anærobic cultivation of the "smears" obtained from chronic joint inflammations might be productive of results not obtained by ærobic methods. Aspiration of joint fluid is very unlikely to yield positive results except where the organisms are present in large numbers. Sometimes where they cannot be demonstrated in this way they will be found in the deep layers of the synovial membrane and can be demonstrated *in situ* by proper staining methods. The work of Schüller, Bannantyne and Wohlmann, Fayerweather, and others working upon chronic joint inflammations has conclusively proven this to be a fact.

It is not however from bacteriologic or pathologic researches alone that the infectious character of articular lesions is to be demonstrated, though the absolute proof to many minds will doubtless rest upon such evidence. Analogy with infectious diseases in the manner of onset and clinical course of the process afford evidence which is not merely corroborative, but if carefully gathered and judiciously weighed may be in itself sufficient to carry conviction regarding the infectious character of the arthritis in question. History taking is of great importance in these conditions. Correlation of the facts obtained in this way with the results of a searching physical examination will usually serve to clear up a majority of the cases and enable a proper classification to be made. Occasionally however one comes across borderland types where a positive diagnosis cannot be established from these two methods of study, however diligently followed out. In such instances, if the opportunity offers, one must avail himself of bacteriologic and pathologic examinations. A determination of the opsonic index in these doubtful cases may be of service in clearing away the obstacles to a positive diagnosis. Unfortunately, some of the organisms capable of producing an arthritis undergo bacteriolysis in the blood stream and are therefore unavailable for the application of this test.

**Etiology.** Viewed from the etiologic standpoint all possible sources of infection must be examined, remote or recent. The infectious diseases, particularly in the younger patients, must be the

subject of inquiry in their relation to the onset of the arthritis. The occurrence of tonsillar inflammations, particularly if the attacks have been oft repeated, may be of much importance; frequent attacks of sore throat usually mean tonsillar enlargement, and the crypts which so frequently occur in such tonsils are often filled with infective material. Enquiry concerning earache, whether with or without discharging sinuses through the tympana, should be made. Pyorrhœa alveolaris is said to be a source of joint infection. Evidences of congenital syphilis in scars about the nose or mouth or evidences of iritis or keratitis must be investigated. The existence of cardiac, particularly valvular, lesions, and the occurrence of chorea, with or without cardiac complications, may be of significance. Glandular enlargements, with or without suppuration, and intra-abdominal or intra-thoracic suppurative processes may throw light on the diagnosis. Long-standing or acute fermental trouble in the intestine may be a source of absorption and infection. Puerperal sepsis and chronic inflammation of the uterus and adnexa, whether demonstrably gonorrhœal or not, may be competent to originate secondary joint inflammations. In the male, inflammations in the deeper urethra, the prostate, and the seminal vesicles are frequently a source of absorption. Fuller has advocated the removal of the seminal vesicles in chronic vesiculitis associated with arthritic symptoms, claiming that the joint inflammations cleared up in a surprising manner after this operation. Chronic suppuration high up in the genito-urinary tract when secondary to venereal disease may also be of significance. Pneumonia and "la grippe" are frequently causes of arthritic involvements. Nearly all of these infections have apparently been responsible for infectious polyarthritis in the experience of various writers.

**Method of onset.** In the determination of the infectious character of an arthritis the method of onset is of great significance. In general it may be said that infectious processes begin suddenly. This is surely true of the more severe infections, e. g. that following gonorrhœa. In certain cases the onset may be slow. In proportion however to the infectivity of the organism we find variations in

the suddenness of onset, so that a failure to conform to the general rule does not necessarily militate against the infectious nature of an arthritis. A second characteristic of infectious arthritis is that it is usually polyarticular at the outset. The first joints to be affected may be only transiently involved, the inflammation finally focalizing upon a few joints, possibly only one or two, which become permanently involved, the force of the infection being at last wholly expended upon them. The fewer the articulations concerned the more severely as a rule are they attacked, and unless fleeting symptoms have been noted in other joints, precedent to the well-established single-joint involvement, very little can be adduced from the history alone to aid in diagnosis.

Another fact of significance, and yet again one which is not infallible, is that an infectious process involves all the articulations that are to suffer in the individual case in a comparatively short time. There is much less tendency toward extension to other joints through long periods of years than is seen in some other types of arthritis.

The physical signs of an infectious arthritis vary with the severity of the infection. Swelling, passive congestion, limitation in motion, impairment in function, muscular spasm, clammy perspiration, and later, in the more severe cases, deformities due to structural joint changes are the chief local signs. General glandular enlargements in many cases with splenic hypertrophy, occasional cardiac complications, secondary anæmia, a slight but continuous elevation of temperature, and an habitually high pulse rate, are evidences of the toxæmia which these cases manifest. Subjectively their complaints are chiefly of pain. This in the severe cases is very harassing, interfering with sleep, producing a loss of appetite, a loss of flesh, and an anæmia which is often of a high degree. Like all persons suffering from chronic disease these patients sometimes become morose, melancholic, and extremely psychasthenic.

**Pathology.** Pathologically considered, this type of arthritis presents a varied appearance. There are certain gross as well as microscopic changes which are fairly characteristic. The gross



appearances of the interior of such joints vary so with the severity of the infections, and probably also with the variety of the organism concerned, that it is impossible to present a picture which shall be constant for all cases of this character. It must also be remembered that in many instances the infection is the result of the presence of the toxins produced by bacteria, and not by the bacteria themselves, and when one attempts to associate pathologic appearances with different varieties of toxins the problem becomes infinitely difficult. It would therefore seem likely that the finer differentiations between infectious processes produced by different organisms will have to be based upon identification of the organism itself, or it may be that clinical signs will be discovered of sufficient constancy to enable us to combine a given pathologic appearance with a given symptom-complex, and to declare that that, and that only, could be produced by the organism in question or its specific toxin. In a general way however the infectious joints appear quite unlike other forms of polyarthritis when viewed from the synovial side. In the first place, the fibrous and synovial capsules, particularly in the more acute or severe infections, are adherent, and it is difficult sometimes to distinguish between the two. The cavity of the joint in the severe infections is entirely obliterated, and the adhesions between the two layers of the synovial membrane are so firm that no force will separate them. The hyperæmia accompanying an infectious process makes this region very vascular. In certain cases the quadriceps or patellar tendons have been ruptured in attempting to break up adhesions in such articulations, indicating that in such cases the adhesions were stronger than the attachments of these tendons to the patella. The subsynovial fat is usually entirely obliterated by the infiltration of the tissues with round cells and the products of a chronic, low-grade inflammation. The combined thickness of the fibrous and synovial membranes is commonly much greater than the thickness of these same membranes seen in other types of arthritis, and when the cavity of the joint is opened, though there may be considerable villous thickening, it is of a different character from that seen in these other forms. The more acute the



FIG. 118. X-ray shows spiculation of bone due to irritation of toxins produced by some infectious agent. Note also capsular swelling and partial obliteration of the cartilage of the joint. This represents the most extreme type of pathological change due to infectious processes in the joints, dissociated from suppurative lesions.

infection the less likelihood is there of a marked villous change being present. An excess of fluid is demonstrable as a rule in these joints, and this fluid varies all the way from pus to a turbid exudate in which there may be present flakes of inspissated fibrin. In a recent case of gonorrhœal origin there was a very turbid fluid present in large quantity, and it was heavily loaded with leucocytes, a very large number of which were phagocytic. (Vide Case II.) The thickened capsule is porky and œdematous in the more severe infections, and the surface of the synovial membrane will be found more or less denuded of endothelium in the most acute types. A vascular pannus often overlaps the margins of the cartilage, and

though the appearance of the surface of the cartilage is not ordinarily changed, in the severer types of infection, especially where actual sepsis has occurred, it may be eroded, and about the erosions one sees a thickened infiltrated border in sharp distinction to the punched-out erosions, and the deep grooves worn through the cartilage from pressure, which one meets in the non-infectious types.



FIG. 119. Illustrates the capsular thickening of the left knee and the possibility of the demonstration of infiltration of soft parts when the X-ray is developed with that point in view. Compare the two knees. The cartilage has not been disturbed in this case.

Examination of the fluid obtained will indicate but rarely the presence of bacteria, because most of the organisms which produce joint lesions are short-lived and are found with great difficulty and in extremely small numbers in the interior of the joints. More success has attended the search for bacteria in the subserous tissues, where they have frequently been demonstrable by proper staining methods. Cytological examination of aspirated joint fluids have proved of no value for diagnostic purposes.

Histologically the villi and the whole subvillous portion of the

capsule is densely infiltrated with lymphoid cells and other cellular elements, which are not seen in acute or subacute inflammations. There is much less subsynovial fatty tissue present and the process of repair as indicated by the presence of epithelioid cells and newly forming connective tissue is in marked distinction from the histological picture of the same tissues in other types. The work of Schüller and of Fayerweather upon the bacteriology of some of the forms of



FIG. 120. Illustrates an acute infectious process in the hip joint. Observe the distortion of the capsule on the left hip.

subacute poly- and mon-articular arthritis has demonstrated the existence of bacteria in many of these cases and has made it seem probable that the future will reveal more instances of the bacterial invasion of synovial structures than we have heretofore believed. Apparently attenuated members of the principal families of bacteria may produce the mild forms of infection. The employment of the opsonic test for the diagnosis of the various types of polyarthritis and their differentiation from each other seemed to offer a prospect of bringing greater exactitude into our knowledge of these subjects,

but up to the present time no great benefit is apparent. In the case of the streptococcic infections it would be impossible to distinguish between the large number of varieties of this organism that might be present. The staphylococcus is never responsible for polyarticular infections and rarely for monarticular ones, except when they are



FIG. 121. Note deformity of left knee, result of an infectious arthritis. Right knee shows scar of an operation for removal of villous thickenings which had been interfering with complete extension of the leg. After that operation extension was possible through practically the entire arc of motion.

direct infections from the outside or a part of a general pyæmic process or due to the extension of a juxta-articular osteomyelitis. It seems probable that a majority of the chronic polyarticular infections, as Schüller has pointed out, are due to an invasion of the joints by the organism which he has described. This view receives

some confirmation from the application of the opsonic test. This has shown a low reaction to this organism in all the cases of chronic polyarthritis in which it has been tried by the authors. Clinically all of the cases yielding this opsonic test have been of the same type. Search is being made for this organism in tissue removed from the joints of patients with this form of polyarthritis who have a low opsonic index to Schüller's organism. There are so many sources of



FIG. 122. Note the sharp flexure of both knees, the result of that form of infectious arthritis known as Still's Disease. Contracture due to reflex irritation of flexor muscles in consequence of inflammation within the joint. No destruction of cartilage. Both knees were straightened under an anæsthetic.

error in the determination of the index that until these shall be eliminated it cannot be taken as a reliable diagnostic aid.

The X-ray furnishes valuable assistance in the study of the pathology of infectious arthritis. (Figure 118.) The lesions of the soft parts can be brought out clearly by carrying the development of the negative to the proper point. (Figures 119 and 120.) The integrity of the cartilage may be demonstrated in the cases where no destruction has occurred, and when the infective agent has been

severe enough to produce cartilaginous erosions they are generally visible in the negative.

**Clinical Course.** In common with all infectious processes and dependent somewhat upon their severity, infectious arthritis begins more or less acutely. From the cases in which the patients state that they were perfectly well up to within a few minutes of the time they were seized with acute pain, to those in whom there has been an



FIG. 123. Note capsular thickening of the second row of phalangeal articulations, particularly of the index and middle fingers on the right hand and ring finger and thumb on the left. Also note capsular swelling of the left wrist joint.

occasional grumbling pain in the joint ultimately severely affected, there are all grades of acuteness of onset. Pain is commonly the symptom which ushers in the attack, soon followed by swelling and disability. Local heat and redness are associated with the more acute types, but all show some elevation of temperature locally and usually more or less congestion, either active or passive. In the larger joints such as the elbow, the knee (Figure 121), and the hip, deformity is an early symptom and the result of an attempt to put the joint in the most comfortable position. (Figure 122.) The cap-

sule (Figure 123) becomes infiltrated very early and presents a boggy, porky feel on palpation frequently, with more or less œdema. (Figure 124.) Fluid is a characteristic of the early stage of



FIG. 124. Note in left knee obliteration of lateral fossæ and the outlining of the capsule of the joint in consequence of its infiltration. This is often visible as well as palpable in this situation.

some of the acute processes, but probably an excessive accumulation of synovial fluid is less often present than has been supposed, so difficult is it to distinguish between the softer villous thickenings and



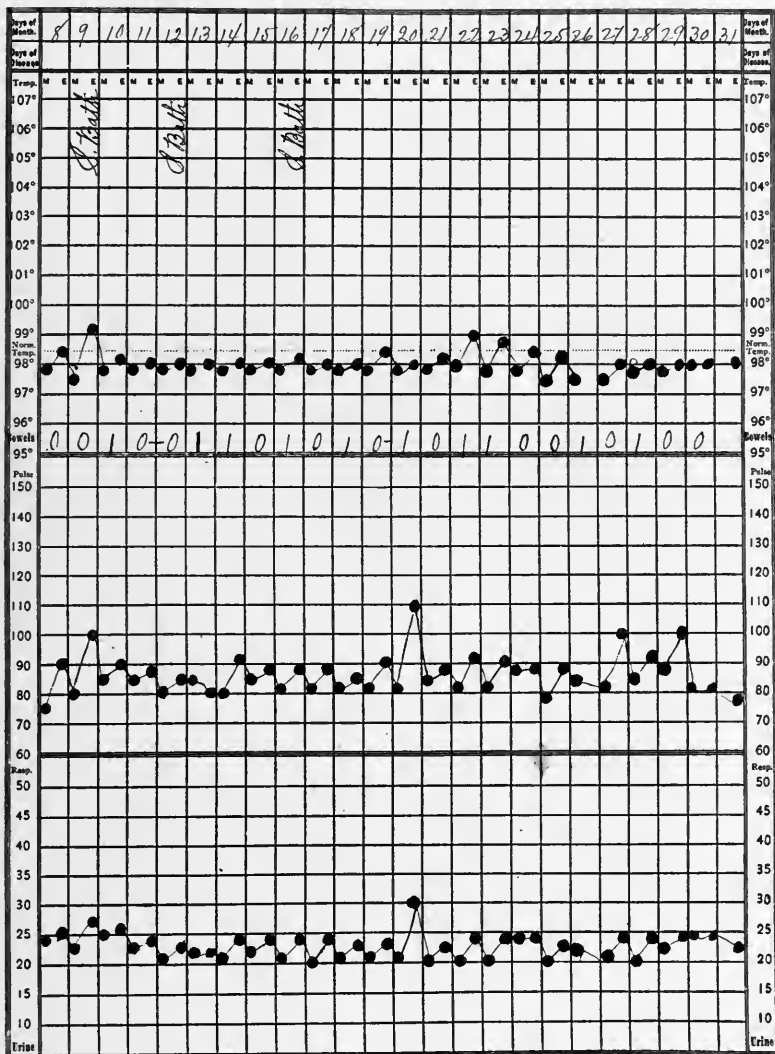


FIG. 125. Note the elevation of the pulse-curve, and compare with chart of atrophic arthritis. Note the discrepancy between the elevation of temperature and the pulse-curve. This is very characteristic of infectious polyarthritis. Cf. chart in chapter on Atrophic Arthritis, on page 292.

the slight accumulations of fluid which are not under much tension.

Constitutionally these patients are sick, the degree of constitutional depression varying with the intensity of the toxæmia and to

some extent with the number and size of the joints which are affected. The temperature is almost always elevated in the acute



FIG. 126. Note the characteristic deformities of infectious arthritis, namely, flexions, shown most clearly in the second row of phalangeal joints. Note also interosseous atrophy,—this deformity due to contracture of flexor tendons in response to interarticular irritation. No erosion of cartilage necessary for this deformity.

stages, though this elevation may be very slight. In the more chronic cases one-half or one degree of temperature (cf. temperature chart, chapter on Atrophic Arthritis) may be carried for many months, and the pulse-rate will be found almost constantly elevated from twenty to thirty points above normal (Figure

125), and this even when no elevation of bodily temperature is present. This is a very striking and we believe a more or less distinguishing feature of infectious polyarthritis. Glandular enlargement occurs with greater or less frequency, but not enough so to lay much stress upon it as a symptom. Splenic hypertrophy and valvular lesions of the heart or endocarditis also are found in a certain number of cases, but here again it is unsafe to lay much stress upon the presence of these symptoms as arguing for or against a diagnosis of infectious



FIG. 127. Illustrates the deformities of the toes which occur in the severe infections of the feet.

arthritis: when present they are confirmatory: when absent they are of no significance as opposing a diagnosis of infectious arthritis.

The changes in the blood are also significant and of fairly constant occurrence in the acute conditions. The patients who suffer from a considerable degree of toxæmia are likely to have a pronounced secondary anæmia. Nothing is shown by the differential count, the test for hæmoglobin and the enumeration of the red cells being the only blood examination which is valuable for diagnosis.

Constitutional symptoms, e. g. malaise, loss of appetite, sleeplessness, etc., are quite constantly noted in the more severe types. In the monarticular and milder infective types correspondingly less constitutional disturbance is to be expected. In the more acute varieties of infectious arthritis symptoms manifest themselves in one or two large joints, to remain only a short time, appearing elsewhere in full force where they may permanently remain. This is notably true of infections with the gonococcus and pneumococcus. The majority of cases of infectious arthritis are polyarticular, and even though a single joint may be primarily affected many are usually involved in a comparatively short time. Usually a few months suffice to determine all the joints that are destined to become involved. Patients with polyarthritis frequently have disturbances in circulation which give rise to abnormal perspiration about the affected joints, the sweat standing out in beads, and this independent of the degree of activity or the conditions of temperature and humidity. This, to



FIG. 128. Illustrates the flexion deformity following an acute infectious arthritis of the hip. The leg was ankylosed in this position.

be sure, is seen in some other non-inflammatory conditions, but is also very characteristic of the frankly infectious types.

(Figures 126 to 136.) One or all of the joints of the body may be involved in an infectious process, probably the most common situa-

tions being the smaller articulations of the hands, the feet, the knees, and the elbows; less commonly the spine, the hip, and the jaw.



FIG. 129. Observe the outward rotation and flexion of the left leg and the capsular thickening over the intra-patellar fat pads, the thickening and infiltration of which have caused the flexion.

**Local treatment.** Recognizing that this type of joint disease is due to an infectious element within the body, and that the continuance of the active joint symptoms usually means continued activity of this infectious element, the first step in treatment is to locate this source of infection and attempt its removal.

If for any reason the source of infection cannot be located and consequently the cause of the disease cannot be removed, every effort should be made to increase the resistance of the individual and make it possible for the organism itself to control the spread of

the disease. With tuberculosis, hygiene alone is depended upon for the arrest of the process, and with the infectious type of joint disease similar principles are of value. Systemic resistance to one group of organisms is not different from that to other groups, and that which has been found so efficacious in tuberculosis should be used in the non-tuberculous infections as well.

Local treatment consists in the protection of the affected joint and a reduction of the inflammation: after this has subsided restoration of function should be the objective of treatment.

In the attempting to remove an active source of infection investi-

gation of the throat and nose with their accessory sinuses, the gastro-intestinal tract, the teeth, the genito-urinary tract, and any other parts that might in the special case be considered of importance should be thoroughly carried out. At times the findings may suggest more than one source of infection, and in such cases it becomes a matter of judgement as to which is the more probable cause or whether both should be attacked.

Treatment divides itself naturally into that which should be directed toward an actually inflamed and threateningly suppurative joint and that which is appropriate for a subacute inflammation or one which has entirely quieted down and left only the products of inflammation. In the acute cases the principles



FIG. 130. Note capsular swelling and subluxation of knees, due to infectious polyarthritis. Also note swelling of the ankles and toes and plantar-flexed position of foot, due to long stay in bed. Knees have been flexed to right angle but forcibly extended under ether.

which govern general surgical procedures are of course to be followed in the infectious processes in joints. They should usually be treated at first by fixation which secures relief from pain, diminishes swelling, lessens infiltration of the periarticular tissues and prevents deformity. To accomplish this ensures greater comfort to the patient and the best functional results in the shortest possible time. In some cases however rest is not the foremost indication at the outset, and it should always be borne in mind that even though rest is generally the initial step in the treatment of most articular infections, more radical procedures may be demanded under some circumstances. The frankly suppurative pyæmic joints require treatment on the broad principle of giving vent to the abscess within

the joint by as thorough methods as can be employed, sacrificing everything to the giving of adequate drainage. In some of the



FIG. 131. X-ray of elbow showing erosion of cartilage and spiculation.

toxæmic joints, particularly those in which the trend seems progressively bad, as indicated by the maintenance of a high tempera-

ture and great sensitiveness, as well as an excessive amount of pain, treatment should be radical, the joint being opened, washed out, any adhesions already formed broken up, and the capsule closed except for a silk seton for temporary drainage, the limb then being fixed in the most favorable position for function provided ankylosis ensues.

The type of infection just referred to is best exemplified in gonorrhœal arthritis. Where surgical interference of this sort is necessary it must be followed up as soon as is permissible by passive and active manipulation of the joints, with the early employment of massage and hydrotherapy. The object of incision and drainage is to wash out of the joint any toxic products that may be there, or the bacteria themselves, if perchance the infection is due to the presence of organisms in the tissues or in the fluid of the joint. Mobility and consequent restoration of function are not always ensured by this measure. Passive and active manipulation are frequently required even at the cost of considerable suffering to the patient before the desired result is attained. In order to ensure a good result attempts should be made by massage and other forms of physical therapy to absorb an infiltration of the capsule which has rendered it stiff or inflexible. In certain other cases of the in-



FIG. 132. This is typical of the so-called "poker" back, an infectious involvement of the spinal ligaments. There was no respiratory excursion. Note the obliteration of the curves.

fectious type it is necessary to do an arthrotomy in order to remove either the products of inflammation, such as inspissated fibrin, or to dissect out the hypertrophied villi which may, on the one hand, contain the organisms which are responsible for the infection, and on the other, may mechanically condition the free use of the joint.

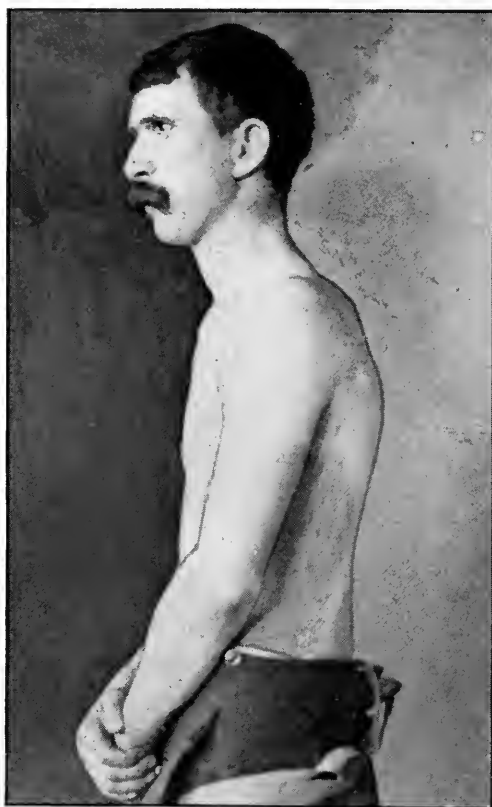


FIG. 133.

FIGS. 133-135. This and the four following figures indicate the restriction in motion characteristic of the infectious involvement of the spine. These should be contrasted with the localized limitation in motion which one meets with in hypertrophic spinal lesions. Vide chapter on Hypertrophic Arthritis, p. 322.

Such operations contemplate the removal of fringes and the subsequent cicatrization of the synovial membrane from which they are detached. If a little endothelial tissue only is left, complete regeneration of the synovial membrane may take place. For this reason a very considerable dissection of the joint capsule can be made without the risk of producing insurmountable adhesions within the articulation.

The method of opening the knee joint which has been suggested by Mayo, namely that of division of the patellar tendon or sawing through the patella, is not a suitable procedure in cases

where the object of the arthrotomy is simply the removal of villi, because of the difficulty of regaining motion. It should be reserved





FIG. 134.

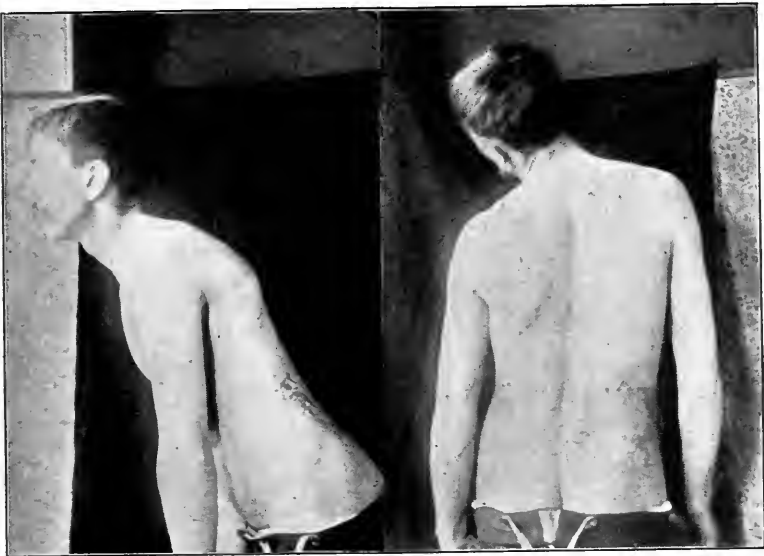


FIG. 135.

for the suppurative cases where the drainage required cannot be obtained through lateral incisions.

In the convalescent stage of many of the infectious arthritides

surgery is employed to overcome the adhesions which have resulted from inflammation. These adhesions occur between the two layers of the synovial membrane and are extremely fibrous and difficult to overcome, particularly in the more severe infections and those which have not been carefully treated from the start. They



FIG. 136. Note swelling above the ankle joint and in great toe, indicative of capsular thickening. X-ray showed no erosions of cartilage in this case.

temporarily, and not much is accomplished thereby. It is in cases of this sort that mechano-therapy has proved effective.

There should also be mentioned a method devised by Baer which in his hands has often given good results. This consists of injecting sterilized olive oil or vaseline into the cavity of such an articulation as the knee. This may be done through a needle after adhesions have been broken up or it may be accomplished when the joint is opened freely and the adherent surfaces separated manually or instrumentally.

In certain joints, more particularly the hip, the elbow, and the shoulder, Murphy's arthroplasty has been tried. Thick pads of fat or fibrous tissue are dissected up from the neighborhood of the joint

also occur between the bones where the cartilage has been eroded. In some cases where the adhesions are few and the infection has not been very severe "brisement forcé" will yield satisfactory results. In other cases where the period of infection is not very far removed from the time of the manipulation the conditions within the joint seem to be aggravated by brisement forcé, at least

which is ankylosed, and turned in to the articulation, so that they cover over the eroded surfaces. This becomes converted to fibrous tissue and prevents the establishment of firm osseous union between eroded bony surfaces. The amount of motion thus preserved does not represent the normal arc by any means, but in the joints above mentioned this is often better than ankylosis. In the knee and the ankle this procedure is not of advantage because the motion secured is not enough. Cargile membrane has been introduced into the joint where good fat or fibrous pads cannot be secured, but this material is apparently too quickly absorbable for use in joints.

These methods do not preclude the necessity of energetic after-treatment but aim to prevent the immediate re-formation of adhesions, so that when the sensitiveness following the manipulation or arthrotomy has subsided progressively increasing motion is possible without great pain. Occasionally after the extremely destructive processes, which every now and then one sees within a joint and which have resulted in a considerable degree of deformity, it is necessary to resort to operative measures to overcome such deformities in order to render the function of the joint better. The time at which these various procedures should be employed and the cases where their employment is indicated have to be determined very largely for each individual case, and general rules cannot be laid down for guidance. These procedures consist of open incision of the joints and breaking up osseous adhesions, e. g., freeing the patella, which is often firmly adherent to the femur. After such adhesions are freed the deformity may be overcome and ankylosis secured in a corrected position. Osteotomy may seem to be the most feasible measure in cases of marked deformity and firm ankylosis. Excision is more appropriate in cases where there is not much deformity, but in which there is incomplete ankylosis combined with great infiltration of tissue by the products of inflammation. It is at times necessary to tenotomize contracted tendons in the course of an arthrotomy or an osteotomy for the correction of deformity. The hamstrings are the tendons most frequently re-

quiring this procedure and the tenotomy should always be performed through an open incision. (Case III, page 288.)

Artificial supports to contracted joints give the patients much relief at times, and should be employed wherever their use would seem to offer a chance of lessening joint strain.

The therapeutic and dietetic treatment must be entirely symptomatic. It is in this class of arthritis, if ever, and even then only in the more acute stages, that restriction of diet is indicated. In the chronic and subacute conditions however ingestion of whatever food agrees with the individual is desirable and in fact in many instances should be urged upon the patient. Massage and hydro- and mechano-therapy, where possible, are adjuncts of treatment which should be employed and are of much service if judiciously used. There is a proper time of course for their employment, and a time when their use is contra-indicated. When the infection is at its height one should avoid the use of such measures, but when the infective process has passed and only the products of inflammation remain within the joints it may be safely inferred that they are innocuous and incapable of causing disturbance by their possible dissemination by mechano-therapy. At any rate, the improved local condition of circulation and local excretory function of the sweat glands is improved to such a degree that the possible harm which might result from dissemination of any remaining toxins is more than counterbalanced.

High frequency currents and electric light and heat baths are finding a conspicuous place in the treatment of this form of arthritis. The effects produced are often gratifying and are probably due to the improvement in local circulation, and the absorption of inflammatory infiltration.

Tonics and iron are desirable in the debilitated states which arise after an acute infection, and extra diet at this time tends to bring the patient back to a normally healthy condition more rapidly than where a rigidly restricted dietary is pursued.

The future of the treatment of infectious polyarthritis will doubtless include the employment of anti-toxines to combat the various

bacteria which may be shown to be concerned with the incitement of these processes. Already good results are being obtained in the cases where the bacteriologic cause for a given arthritis has been demonstrable. There are several serums upon the market that may be employed. The difficulty is that they are necessarily used blindly and will be so used until it is possible to positively associate a given organism with a given set of symptoms. As a result of Wright's studies it has been shown that vaccines to be of the greatest value in the treatment of infection must be made from cultures of the organism producing the lesions to be treated. This precludes treatment by this method in very many joint infections because of the difficulty of obtaining the causative organism in pure culture. In the practice of the writers a considerable number of cases of infectious polyarthritis have been treated by this method for considerable periods of time but no beneficial results have been obtained.

These cases often require more moral support and encouragement than physical therapeutics. If one neglects this psychic factor or lacks perseverance a relatively remediable condition may become one which is perfectly hopeless.

The importance of position during bed treatment can hardly be overestimated. Failure to recognize this is responsible for many deformities which have to be dealt with after bed treatment has been completed. Plantar-flexion of the feet, flexion at the knees and hips, kyphosis of the trunk and flexion and abduction at the wrists as well as luxations and flexions at the phalangeal articulations are the more common and distressing of these deformities. If they are not allowed to develop one at least of the complications of infectious arthritis will not subsequently demand treatment.

Phthisis is most prone to develop in the spinal cases in which the importance of this postural factor has not been recognized. The stoop shoulders, narrow chest, and rigid rounded spine make any thoracic expansion almost impossible and render the lungs most susceptible to invasion by the tubercle bacilli.

In the active stage therefore recumbency should be maintained as completely as possible. Patients should not be constantly propped

up with pillows and the position of hyperextension should be assumed at least once daily in order to prevent the formation of adhesions in a malposition which is fraught with future menace.

**Prognosis.** The outlook as to life in cases of infectious arthritis is good in the majority of instances. Certain of the more severe infections, particularly those caused by the pneumococcus, the streptococcus, and occasionally the staphylococcus may produce metastases, from which death may ensue. Aside from these cases, life need never be considered in danger in an uncomplicated infectious polyarthritis. It is doubtless somewhat shortened in the severe infections through depression of the constitutional vigor, and as has been stated under treatment, in those cases where the spine and ribs are involved phthisis frequently attacks the patient because of interference with respiratory function. The course of the disease is invariably long, covering several years, even under the very best of conditions unless the focus can be found and eliminated, in which case the rapidity and completeness of recovery is at times remarkable.

Prognosis as to function and restitution of the joints to a fairly normal degree of usefulness is good in many instances under proper treatment. This is true because of the fact heretofore pointed out that the process involves principally the synovial and subsynovial capsular tissue, and does not ordinarily attack the cartilage or bone. For this reason the whole question of prognosis regarding ultimate usefulness lies in the ability to favor in some way the absorption of infiltration in the capsule. If this can be brought about the articulating cartilages will be found to be capable of performing their functions. In cases requiring arthrotomy or manipulation complete restitution to normal motion is not assured, though many of the arthrotomies performed for this purpose have been attended with such results. It must be remembered that very considerable restrictions in normal motion are consistent with good function, provided deformity does not interfere with the employment of the motion remaining. It is also worthy of note in giving a prognosis that in the chronic cases "improvement" must not be measured by customary

standards. A degree of betterment in the usefulness of the joints of a sufferer from infectious polyarthritis, which would seem insignificant when measured by normal standards, seems very considerable from the point of view of the patient. The prognosis however varies with the type of infection and with its severity, both as to ultimate function and as to duration of life itself. Bacteriology has much to teach us with reference to the possible organisms which may be concerned in this process, and until such investigations have been completed we shall be in no position to be dogmatic in prognosis. In order to make more clear the type of arthritis which has been described in the foregoing discussion the following cases are cited as being representative of polyarticular joint inflammations.

**Case I.** F. S. Age, 11 years.

This patient was first seen September 19, 1905, complaining of "rheumatism" in the feet and legs and a general run-down condition. This had lasted for two or three months and was gradually growing worse.

Physical examination. — Rather poorly developed and nourished child. There is no limitation of motion or other symptoms in any of her joints, except in the ankles, which are tender, especially when attempts are made to adduct the feet. These were swollen, tender, and covered with clammy perspiration. There is no acute swelling, but some sensitiveness. Feet are both markedly pronated and the arches are relatively low when the weight is borne.

General treatment advised and plates made to support the arches.

It appeared on further questioning that during the previous June, together with other children in the family, she had had an attack of tonsilitis, and one week after the acute sore throat developed joint symptoms suddenly appeared, evidently representing an acute infection secondary to the throat.

The wearing of plates relieved the condition in the feet somewhat, but the succeeding October the patient was again examined and moderate periarticular thickening was found around the second and third metacarpophalangeal joints of both hands. Similar swelling

of the right ankle and tarsus. The right tonsil large and flabby; the left shows numerous follicles, but not as large as on the right. Considerable redness of the faucial pillars.

Examination of the blood at that time showed 95 % of hæmoglobin, ten thousand whites, and six million reds.

On account of the inflamed condition of the throat it was deemed advisable to remove the tonsils. This was accordingly done, and within two or three weeks succeeding the excision of the tonsils the joint swellings entirely disappeared, and have never recurred.

**Case II.** Mr. W. C. was first examined on December 15, 1902, when he was 38 years of age.

Family history good.

Previous history. — Has never been sick, and has worked hard as a machinist in the mines in Old Mexico. Exposed to severe changes in weather and temperature, and has been very careless in the care of himself. Gonorrhœa six years ago. Three years ago began to have twinges of rheumatism shifting about from the shoulders to the arms. Two and a half years ago went to Hot Springs in Mexico and grew rapidly worse; lost fifty pounds in a short time. After he left the Springs he improved gradually for a few months, then had a violent attack. Has had two acute inflammatory processes since; one a year and a half ago and the last three months ago. Has been confined to bed several months during each attack. Has been in the East one and one-half years, most of the time in Maine. Is now perfectly helpless.

Physical examination. — In fair general condition. Color good. Typical spindle-shaped swellings of the right hand, wrist, left shoulder, left hip, and both knees. Joints markedly swollen, due largely to capsular infiltration without adhesions. Both knees sharply flexed, as are also the hips. Skin moist. Suffering a good deal of pain because of the contractures of his knees.

January 4, 1903. — Since the last note has been in the hospital and had repeated forceful manipulations of his knees, hips, elbows, and fingers. The knees are practically straight, and there are a few



degrees of motion in the joints; also sufficient motion in the elbows to permit of his getting his hands to his mouth. Given several inoculations with anti-streptococcic serum without result.

April 3, 1904. — Has improved considerably. Is able to be on his feet, walking and standing, for an hour at a time.

July 1, 1904. — Under gas both knees were manipulated. Evidently erosions had developed on the patella and the femur, causing adhesions which it was impossible to break up, though about 20 % of flexion was secured. 30 % of free motion was obtained in the right elbow. Following this passive manipulations were carried out through the summer, and between this date and November 8, 1904, he had three further manipulations of the elbows. Left elbow can be flexed through an arc of 20 to 25°, and extended to within 25° of complete extension. Right elbow can be extended to the same amount and flexed through an arc of 45°. Left patella adherent; right can be moved a little, but practically all of the ten degrees of possible flexion in the knees is due to the stretching of the patellar tendon. Both feet can be flexed to a right angle, and patient can walk quite freely with the aid of a caliper splint and crutches.

August 24, 1905. — Has steadily improved this summer while living out of doors in a tent. He has more and freer motion in the elbows and slightly more in the right knee; not much if any more in the left than there has been. Wrists have a good deal of motion. Can walk round the grounds with one splint on and remain on his feet for two or more hours at a stretch.

February 1, 1907. — Patient reports that he is in about the same condition as at the last note. This patient has had a number of attacks of gonorrhœa as a result of which he has had a chronic seminal vesiculitis. Both vesicles were palpably enlarged and considerable detritus could be expressed from them on rectal massage. It seems probable that this condition has been the source of these repeated joint inflammations. He has had during the course of his arthritis two sharp attacks of pleurisy during one of which there was considerable effusion.

**Case III.** J. M. Age, 25 years. April 18, 1906.

Occupation. — Wine clerk.

Diagnosis. — Intermittent hydrops (knees).

Complaint. — Pain and swelling in both knees.

Duration. — Nineteen months.

Cause. — Gonorrhœa.

Previous history. — Measles two years ago. Gonorrhœa five years ago and again one year ago; otherwise negative.

Family history. — Negative.

Present illness. — For nineteen months there has been swelling in both knees which has alternated periodically. The cycle occupied by the swelling in each knee covers a nine-day interval, the maximum size being attained at about four days, and five days being required before the swelling entirely disappeared.

At the present time the right knee is beginning to swell. There is some pain during the period of greatest distention of the joint and a moderate amount of limitation in motion is notable at this time also. There is some tenderness and increase in surface temperature when the joint is most swollen. The quadriceps pouch is enlarged. No other joints are involved. The right knee on this date was  $\frac{1}{4}$  cm. larger than the left over the patella, 1 cm. smaller above the patella and 1 cm. larger below the patella. On the 19th the right was 2 cm. larger over the patella,  $3\frac{1}{4}$  cm. larger above patella and  $2\frac{1}{2}$  cm. larger below patella.

Operation. — Under ether an incision was made over the inner side of the right knee and the joint capsule was found to be very markedly infiltrated. A flocculent, straw-colored fluid escaped when capsule was incised. There was considerable formation of villi and these were dissected out as thoroughly as possible. The joint was irrigated with hot sterile salt solution and capsule closed with interrupted silk, the skin closed with interrupted silkworm gut.

A long series of observations was made by measurements of the knee joints following this operation and there was no swelling of the right knee after the arthrotomy, the intermittent swelling having been entirely broken up.

On examination of the fluid which was obtained, an encapsulated diplococcus was found which failed to stain by Gram's method.

On May 19, 1906, the left knee which was found swollen was operated upon because of the apparent improvement brought about by arthrotomy of the right knee. A similar operation was performed under an anæsthetic through a curved incision over inner side of left knee. Cultures were taken from fluid which escaped after capsule was incised, and showed the same growth found at operation upon the other knee. It was similarly infiltrated. There were many villi within the joint, and along the margins of the cartilage on the femoral condyles were several hypertrophic nodes about the size of a kernel of rice. Several of these were removed.

Similar series of measurements were made after this operation upon this joint and the one previously operated.

On June 12, 1906, patient was discharged from hospital much relieved.

On January 1, 1907, the patient was heard from and up to that time there had been no recurrence of the intermittency and the function of the joints was very good.

#### **Case IV. N. S. 38 years of age.**

The patient has had rheumatism off and on since she was nineteen years of age, the disease being characterized by many exacerbations, none of them enough to confine the patient to bed but interfering considerably with her activities. The patient has always had throat trouble, having had one or two definite attacks of tonsilitis, the last and most troublesome attack of rheumatism coming on in connection with an attack of tonsilitis.

At the time of the examination the feet were much swollen congested, and painful. The knees, hands, and elbows were also somewhat involved. The patient had gradually grown worse, having lost much flesh, each attack leaving her more helpless than the previous one.

The case was so obviously due to absorption from the throat that

an operation was performed for the removal of the tonsils; following this operation and combined with local treatment for the joints almost at once the improvement in the arthritis commenced. Within two months the symptoms of inflammation in the joints had practically disappeared.

**Case V. Mrs. H. 48 years.**

The patient for several years has had slight attacks of rheumatism, but not enough to cause any serious inconvenience until four years ago when she had a severe attack of la grippe. This was followed by a very obstinate bronchitis, which has persisted up to the present time (1906), and shortly after the development of the bronchitis the joint symptoms developed and have gradually progressed, until at the time of the first examination the patient was markedly crippled. The hands, feet, elbows, and shoulders show distinct involvement, with swelling, limitation of motion, and marked loss of function.

The general examination which was carried on in the study of the case showed pure culture of the "grippe" bacillus in the sputum showed one antrum to be filled with fluid and one frontal sinus also in the same condition. There was also disease of the ethmoid cells.

For treatment an operation was performed, the antrum drained, the frontal sinus opened and drained, and the ethmoid cells treated.

Within twenty-four hours after the operation the cough, which had been up to that time almost incessant, became much less marked, and within a day or two practically ceased. The joints were protected by bandages. Gradually from this time the joints improved, until within five or six months they were practically restored to their normal condition.

At the present time (1908) the patient is well, there having been no return of the bronchitis, and no recurrence of the rheumatism. The patient has led a free, active life since the commencement of treatment.

**Case VI. A. P. R. 47 years.**

The patient, a physician, has devoted himself most rigorously to his profession, rarely taking vacations. For eight or nine years has had some trouble with his throat, but not enough to confine him to the house. For many years he has had psoriasis, almost the entire body being covered, a condition which has yielded little to any form of treatment. This had caused no special inconvenience, and he had considered himself, except for this, practically well until two or three years previous to the time of the first examination, when he began to have pain in the back and legs, being especially stiff after sitting. The condition gradually increased, and six months before the examination a definite inflammatory condition developed in several of the joints, one knee, one foot, and shortly after this the jaw, the left shoulder, the wrists, and hands. The condition had continued until the time of the examination, the patient having been much disabled by it.

At the time of the examination there was a mild inflammatory condition of many of the joints, and as both tonsils showed some signs of chronic disease, an operation was performed for the removal of these. No material improvement followed this, and as the examinations of the intestinal contents suggested an abnormal condition with possible absorption there, the patient was started with regular doses of Beta Naphthol, five grains three times daily, and flushing of the bowel each day by means of a normal salt solution. Butter-milk was made the chief part of diet. The patient was kept in the open air, living under the most perfect hygienic conditions during the summer of 1908. With the continuance of this treatment there was a gradual improvement in all the symptoms, so that at the end of four months almost the full use of the joints was possible, and coincidentally with the cessation of joint symptoms the psoriasis also disappeared. At the time of the last examination (Nov., 1908) there was little if anything to show of the psoriasis or of the joint changes.

## CHAPTER II

### ATROPHIC TYPE. RHEUMATOID ARTHRITIS

UNDER this latter term a form of chronic polyarthritis has been described by Continental and English writers. Owing to the lack of exact clinical observations and discriminating pathological study much confusion has existed for many years as to the clinical course and history of this disease, and doubtless many conditions which may not properly be included here have been described under this name. That it is a clinical entity however, recent pathological study and more thorough clinical investigation seem to have proven beyond any reasonable doubt, and although there are still difficulties in the way of a positive diagnosis in cases which approach the border line of the better known types of arthritis, yet our constantly increasing ability to make finer distinctions in physical signs enables us in a great majority of cases to make an exact diagnosis.

**Etiology.** This disease occurs very widely distributed in all parts of the world, but it is a fact of etiological interest that it is most frequent among races in whom civilization has attained its highest degree of development. It belongs to adult life in its middle and early periods, and is found most frequently among women, although instances among men are not at all uncommon, and in spite of the contrary opinion of some writers, it is rarely seen before the fifteenth or twentieth year. (Figure 137.) The cases of arthritis occurring prior to that age can doubtless be classified under the type described by Still, which we now believe to be an infectious form of arthritis, having no definite relationship to the disease under discussion. (Figure 138.) In England particularly "rheumatoid" disease has been described among young people.

There is a conspicuous absence in this disease of the factors which

are generally conceded to indicate an infectious etiology. Careful inquiry will yield negative results in the search for sources of absorp-



FIG. 137. Photograph of a typical case of atrophic arthritis in a middle-aged woman. Note the deformities at the second phalangeal articulations of both hands, the flexion of the left wrist, the interosseous atrophy, and the capsular thickening and subluxation of the metacarpo-phalangeal joints of the index and middle fingers of the right hand. Also observe the hyperextension of the second row of phalangeal joints of the index, middle, and ring fingers of the left hand, and the index and middle fingers of the right hand. Cf. these lesions and those of the infectious polyarthritis (Still's Disease) shown in Figure 138.

tion from the various portals of entry of infective agents. Observers in the past have claimed that bacteriological sources were demonstrable for this type of arthritis, but more careful study and a com-

parison of the facts derived from clinical examination with those brought out by pathologic investigation indicate that the former ground is not tenable. The onset in itself is not such as would suggest an infection. In an aggregate of patients so large as to indicate a causal relation to the joint manifestations, there has been observed an association of such factors as grief, fear, severe nervous shock, and great physical or mental strain. Traumatism apparently plays no part in the etiology, except where it is accompanied by a severe traumatic neurosis, as for example in the "railway spine." The greater frequency of this disease in women, who are more subject to nervous disturbances, would also point to a close relationship between the joint manifestations and nervous exhaustion. In a consideration of the etiology however one must distinguish between the nervous exhaustion which is a causative factor and the nervous exhaustion which not infrequently develops after the disease has become established, and which might otherwise be described as nervous prostration.

The social condition of patients who suffer from this type of joint disease is worth considering. It chiefly affects the poor and the middle classes, although the well-to-do are not free from its inroads. The general wear and tear of life and the exigencies of poverty seem in some way to contribute to its development. Among the well-to-do, such factors as grief, accident, and its attendant nervous shock, play an important part in the etiology, while among the poor the responsibilities and actual physical strain of family and household duties contribute to its production. Individuals of a nervous temperament and with slight physical vigor are likely to fall a prey to this trouble. In the majority of cases occurring among men the same kind of influences that have been noted among women is operative.

**Pathology.** A study of the pathological lesions presented by this type of joint disease is of much interest. Owing to the confusion existing with reference to its pathological changes the disease has not been properly classified among the large group of arthritic conditions, and there has been too great a tendency to regard the ter-



minal lesions, which present scarcely any of the characteristics of the acute stage, and represent in point of fact a stage of repair, as characteristic of the fully developed disease. This error has been



FIG. 138. Photograph of a patient eight years of age suffering from the type of arthritis known as "Still's Disease." Note the spindle-shaped swellings of the hands and the marked enlargement of the wrists. Contrast with Figure 137, page 293. Note the tendency is toward flexion deformities, and that there are no hyperextensions.

due to the fact that until very recently most of the material which has afforded opportunity for a study of the pathological lesions of the atrophic type has been obtained from almshouses and dis-

secting rooms, where only its last stages could be studied. It is only since it has been found that in suitable cases surgery is capable of



FIG. 139. An X-ray of the hand of a patient suffering from atrophic arthritis. Note atrophy of cartilage between the bones and the swelling of the soft parts, which is particularly well shown at the joint between the second and third phalanges of the middle finger. Observe the absence of any spiculation and irregularity about the seat of the joint lesion in contrast to the X-rays of finger joints affected by the hypertrophic type.

rendering some aid to these sufferers that any exact knowledge of the essential pathology has been acquired.

During the more acute stages of the process surgical interference is sometimes justifiable, and material obtained from such cases has enabled us to draw some conclusions regarding the significance of the tissue changes which occur. (Figure 139.) These changes are found to involve all the structures of the joint, — the cartilage, bone, synovial membrane, and at times the fluid which lubricates the joint. The earliest lesions in the tissues of the joint occur in the synovial membrane, and take the form of what is perhaps

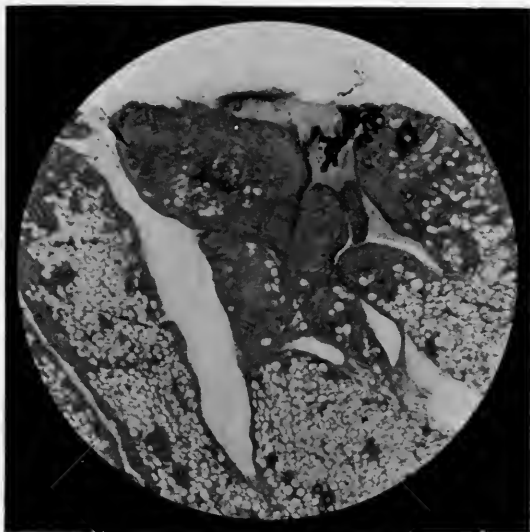


FIG. 140. Note the infiltration of the tip of the villus shown in the centre of the field. The upper part of the villus nearest the base shows fatty degeneration.

best described as a villous arthritis. The normal tissue elements of this structure undergo hypertrophy and round-celled infiltration becomes pronounced, particularly in the tips of the villi. (Figure 140.) These villi become individually and usually irregularly enlarged, so that when the membrane is looked at *in situ* it presents the appearance of a piece of velvet with a very coarse, irregularly roughened nap. The color is a reddish-purple, in consistency the tissue is more friable than normal, and the whole surface is very vascular and passively congested. Except for the above-mentioned round-celled infiltration there are very few abnormal cellular elements present, only occasionally a lymphoid or plasma cell. On section, one notes a great excess of blood vessels, and the fat which backs

up the synovial membrane is slightly increased in amount, even in the early stages of the disease. As the process advances, the cellular infiltration along the border of the synovial membrane gives way more and more to fibrous tissue, the fat becomes disproportion-



FIG. 141. Note the rarefaction of bone, the atrophy of cartilage between the metacarpo-phalangeal joints, and the ulnar deflection of the hand and luxation of the terminal phalanx of the thumb, these representing the chief deformities to which atrophic arthritis gives rise. Observe that the terminal phalangeal articulations show no cartilaginous atrophy.

ately prominent, the blood vessels show endarteritic changes, vascularity of the tissue becomes less and less, and the gross as well as the



FIG. 142. Drawing of dry specimen of atrophic arthritis. Note erosions on the external femoral condyle and also on the tibia.

histological appearance partakes more and more of the characteristics of a cicatrization. These changes take place only after long

periods of time, varying from one to four or five years, according to the resistance of the individual and his capacity for repair.



FIG. 143. Side view of same case shown in Figure 142. Note the thinness of the patella and the erosion of the femoral condyle.

The next lesions, in point of time, occur in the cartilage, which loses its customary glistening appearance, becomes duller, and in

some instances gradually develops evidence of longitudinal striation. There is also a diminution (Figure 141) in thickness occurring symmetrically all over the bearing surfaces of the cartilage, which in certain situations may go on far enough to produce erosions,

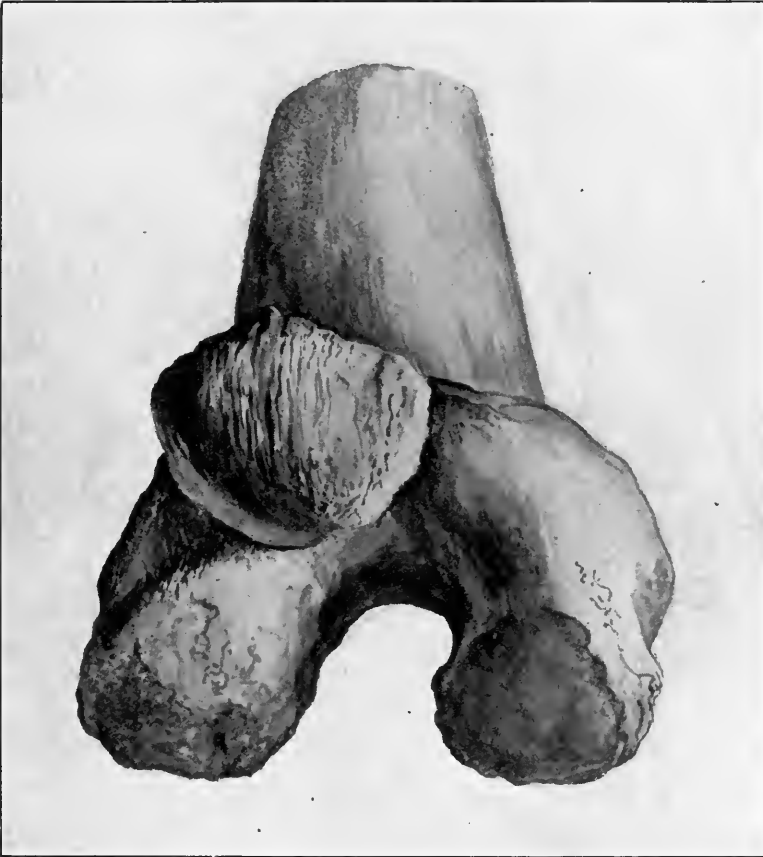


FIG. 144. Note the erosion of the internal and external femoral condyle.

varying in size from an area as large as a split pea to that of a five-cent piece. (Figures 142, 143, and 144.) Such erosions however are usually small, and may occur on opposite sides of an articulation so that the denuded surfaces may be brought into apposition with each other on attempting to move the joint. In the

more extreme cases this shrinkage of the cartilage may go on to such an extent that there will be only minute islands of cartilaginous tissue appearing on the surface of the joint. (Figure 145.)



FIG. 145. Micro-photograph of the trochlear surface of the lower end of the humerus. The dark areas indicate eroded spots, whereas the lighter areas indicate the remaining cartilage. This condition extended over the entire trochlear surface of the humerus.

Around these erosions there are no evidences of inflammatory change, while through their bases one can see the bony trabeculæ beneath, and in the spots where the cartilage is about to be eroded a fine vascularity gives early evidence of beginning absorption. When the actual erosion takes place this vascularity

disappears, and a fibrous tissue, very well seen on histological examination, attempts to bridge over the eroded surface of the cartilage. Under the microscope very little change is to be seen in the cartilage other than this diminution in thickness, and in cases where erosions have occurred, the bridging over with fibrous tissue which is more or less infiltrated with round cells as has already been described.

The lesions in bone are the last to appear. Their occurrence is due partly to the imperfect function of the joint, and partly to the disease itself. Other forms of arthritis with a similar degree of interference in function are not characterized by the same osseous tissue changes. Grossly, in the advanced cases, the intertrabecular fat is enormously increased, the trabeculæ themselves are fewer in number (Figure 146) and smaller in size, and the intertrabecular spaces are very much wider than normal. On rubbing the finger across the cut surfaces of bone in these advanced cases one finds that the surface feels not unlike the edge of a wire screen, while in normal bone



there is greater smoothness of the cut surface because the normal intertrabecular tissue fills the spaces more completely. Under the microscope the gross lesions just noted appear very prominently. The trabeculae are actually smaller, seeming to intercommunicate with each other less frequently, and are diminished in number. The nuclei of the bone cells stain normally, the fat tissue is in great excess, and the blood vessels, in the early stages, are increased in a proportion like to that noted in the early stages of the villous change in the synovial membrane. As the process advances, endarteritic changes similar to those noted in the vessels of the soft parts are observed in the vessels occupying the intertrabecular spaces. The synovial fluid shows practically no departure from normal except occasionally in the acute stage of the more advanced cases, where it is often apparently in excess. A careful examination of the joint will in most instances satisfy one that the swelling is not due to an accumulation of fluid, but to villous thickening of

the soft parts. Metaplasia is noted quite frequently in the synovial membrane in this disease. Islands of bone and cartilage (Figure 147) have been found scattered through the hypertrophied synovial villi. Sometimes in the long-standing cases, where there has been some excess of fluid, fibrin is precipitated out of the fluid and clots



FIG. 146. Note the small number and attenuated size of the bone trabeculae. This is a micro-photograph of a section of atrophic bone. The specimen was removed from the head of the femur after an excision. Note the excess of fat in the inter-trabecular spaces.

are formed within the joint. Where this phenomenon is noted however it is always necessary to exclude the possibility of an infectious arthritis, as it is this form which most commonly produces such effects in the synovial fluid. Bannantyne and Wohlmann undertook to prove that bacteria could be obtained from the fluid of joints of this description, but although they claimed at first to have succeeded in inoculation experiments and to have secured sufficient evidence to clearly demonstrate the relationship of bacteria to the development of these lesions, other investigators have not been able to confirm their observations. In the light of our greater knowledge of the clinical side of this disease, and in view of what we now know of its pathological changes, it would seem that the type of arthritis which they were considering, and in which they may have found their organisms, must of necessity have been an infectious arthritis. Schöler, in Germany, reports similar results but is evidently working with the infectious form of polyarthritis.

A further source of information as to the etiology of this type is to be obtained from a study of the metabolism of the body. Careful quantitative analyses, covering the metabolism of calcium, magnesium, phosphorus, and sulphur, have shown that except in the amounts of phosphorus, calcium, and magnesium excreted (McCrudden) and the relationship between the proportions of these elements to each other, there is little change in the chemical processes of the body, and so far as determined by metabolic study, calcium which is contained in the bones, principally in the form of the oxide has been shown in the few atrophic cases subjected to analysis to be excreted in more than twice the amount in which it was ingested, and the relative proportion of magnesium and calcium is exactly reversed. In this form of arthritis the phosphorus excretion has fluctuated with the calcium. This fact, together with the facts derived from a study of the X-ray shadow and the histological appearance of the bone in this type of arthritis, would suggest that the calcium which is shown in the metabolism experiments to be lost was derived from the normal calcium content of the osseous skeleton. In further confirmation of this, a patient has been subjected to meta-

bolism experiments on two separate occasions, once when she was in the acute stage and the joints were becoming successively involved, and again two years later after the disease had become quiescent. In the first experiment the results were such as we have indicated above; in the second, metabolism had been restored to that of a normal individual, or approximately so. So far therefore as the pathological or physiologico-chemical factors are concerned in the production of this disease, it is not unfair to state, in view of the fact that no bacteria have ever been conclusively demonstrated

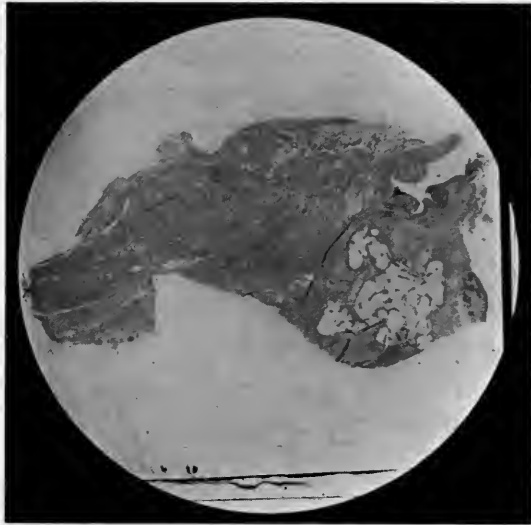


FIG. 147. Micro-photograph of a fringe removed from case of atrophic arthritis, illustrating metaplasia. In the lower right hand corner are small masses of bone and cartilage in the substance of the fringe.

in this type, and that histological study shows no lesions typical of bacterial invasion, that there is no bacteriologic cause for the development of symptoms in the atrophic type of non-tuberculous arthritis. A toxæmia acting through the central nervous system has been suggested in explanation of the joint lesions, but has no facts to support it, though numerous autopsies have been performed and lesions of the central nervous system as well as of the peripheral nerves have been carefully sought. We are then left to conclude, as the most reasonable hypothesis, that the explanation of the phenomena lies in a disturbance of the nutrition of the joints, which may be influenced through a nervous mechanism which it is not yet possible to demonstrate anatomically or through chemical processes not now understood. It is possible that the future may prove that

this type of arthritis is associated with the secretory functions of the glandular structures of the body. The relations of these to metabolism is not clear. It will of course require longer study and more observations than are at present available to fully establish this hypothesis, but the more one sees of the disease, the more one becomes convinced that some such explanation will one day find positive substantiation.

**Clinical history and course.** The atrophic type of non-tuberculous joint disease is a polyarticular affection, beginning usually in the smaller articulations of the hands and extending to other joints in more or less rapid succession. It is practically never mon-articular, and the large joints are usually the last to show signs of trouble. The fingers, wrists, the elbows, the knees, the joints of the tarsus and metatarsus, the shoulders, the jaw, and the spine represent about the usual succession of events by way of joint involvement. The spine is attacked very much less frequently than by either the infectious or the hypertrophic types. The patient first notices some slight lameness or stiffness, with disturbances in the circulation, evidenced by abnormal sweating of the hands and feet and coldness of the extremities. The disease is characterized by gradual capsular infiltration, the explanation of which has already been indicated under the discussion of pathology, and this is confined to the synovial structures, with very little if any excess in the amount of joint fluid. There is a gradual tendency to deformity, usually a flexion or subluxation as distinguished from the prevalent lateral deformities which are noted in some other types of arthritis, and this is of considerable diagnostic importance. These deformities occur in nearly all of the cases to a greater or lesser degree. Sometimes when the disease is spontaneously arrested the deformity may be overcome, but as a rule a certain degree of permanency remains to all the deformities which result from atrophic lesions. (Vide Figure 141.) The explanation of these deformities is that the particular change in the joint characteristic of the atrophic type takes place in the cartilage (Figure 148), which becomes thin, and therefore occupies less room in the joint than normally. Figure 149.

Previous to the thinning of the cartilage however the synovial membrane has undergone a villous change, and this has taken away from the elasticity of the joint capsule, so that it cannot shrink to fit the thinned cartilage. The muscles which are attached about the joints, of which the flexors are always the stronger, now tend to pull the relaxed articulation into a position of deformity, and consequently the more distal bone is pulled



FIG. 148. Photograph of a plaster cast taken of atrophic hands. Note the sulcus at the line of articulation between the second and third phalanges and to a lesser extent between the first and second, this being due to an atrophy of the cartilage between the bones.

back behind the proximal one, or subluxated to a greater or lesser degree. More rarely do lateral deformities occur, the most conspicuous of which are the ulnar deviations of the hands and knock-knee deformities which are usually associated with subluxations of the tibia. The smaller joints are earliest affected, but if the disease progresses one after another the larger articulations succumb, and in the most extreme cases every joint in the body may be involved. Pain as a symptom of this disease is usually not as severe as that which is associated with distinctly inflammatory conditions. In the early stages there is very little of it. When it becomes

pronounced it indicates the development of erosions, either actual or imminent. Along with this painful symptom one notes crepitation, which is usually due to the eroded surfaces rubbing over each other in the act of flexing and extending the joint, and also the chafing of enlarged villi over each other. At times the joints become quite firmly fixed because of the large number of erosions and the muscular spasm which is reflexly aroused. In some cases there is doubtless a bony ankylosis (Figure 150), though it is never as firm as bone not so rarefied. In the most extreme cases, where only small islands of cartilage remain, flexing or extending the joint is accompanied by a jerky sensation as the articular surfaces in play are first smooth and then eroded.

The constitutional disturbances which characterize this disease are proportionate to the extent of joint involvement and are not due to toxæmic conditions, but are apparently dependent upon interferences with the functional activities of the body as a whole. In infectious articular processes the constitutional effects of the disease are proportionate to the intensity of the infection, and will be seen to improve as the toxæmia lessens. In the atrophic cases the constitutional disturbances are certainly no less marked when the individual joints become less acutely disturbed. In other words, the characteristic of the general condition of a patient who suffers from multiple atrophic lesions is malnutrition, not necessarily displaying itself in the form of a loss of flesh, for patients are oftentimes fairly well nourished, but in the form of muscular atrophy, poor circulation, parchment-like, anæmic skin, general lassitude, and the pinched and drawn facies which is an indication of mental distress and physical suffering. The suffering which produces this appearance is not wholly due to pain, but to inability to place the affected joints in a comfortable position; it is also in large part due to the hopelessness confronting the sufferer from this trouble at all times.

In the more advanced cases the atrophic changes are noted in the skin and nails. The former becomes shiny, almost parchment-like, and the function of the sweat glands is considerably disturbed



FIG. 149. Note the loss of cartilage between the carpal bones and between the radius and the carpus; also between the second and third phalanges of the ring finger. Compare this latter joint with the corresponding joints of the index, middle, and little fingers.

dryness of the skin being a very characteristic feature in the advanced cases. The nails may also become thickened, striated and much deformed, and may be exfoliated from time to time.



FIG. 150. Note the atrophy of the patella and the fusion of the two bones, due to an entire disappearance of the cartilage between them.

**Blood.** Examination of the blood shows surprisingly few changes, less even than would be oftentimes anticipated from the appearance



of the individual. One would naturally expect a certain amount of anæmia to follow such a condition, but a considerable number of examinations made at the time that the disease was actively progressing have shown an approximately normal number of red corpuscles with a high carrying capacity for hæmoglobin. (Erving.) In fact, several of the patients who were examined showed a red blood count rather above the normal. In the white cells there is no change of significance.

**Temperature.** Repeated observations upon the temperature of these patients show that they carry no fever, and even though at

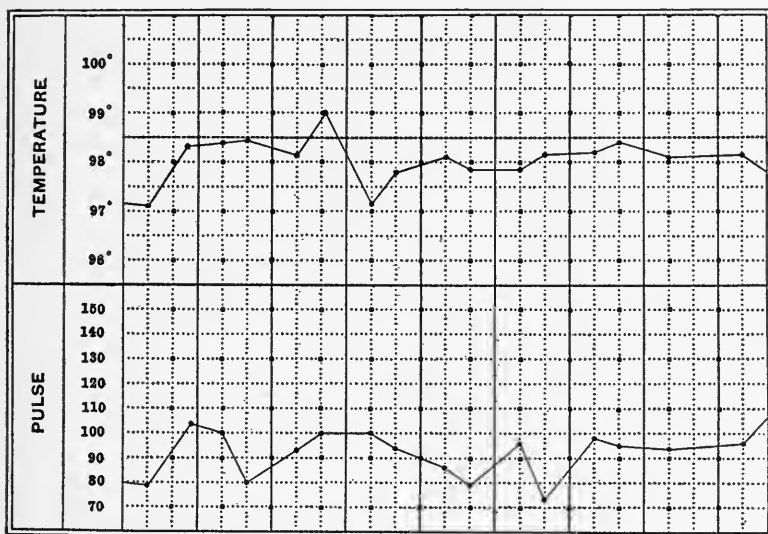


FIG. 151. Shows a typical chart of infectious arthritis. Pulse and temperature curves are bearing the usual relation to each other.

times there may be great local tenderness and moderate increase of surface temperature, this is not reflected in any way upon the temperature chart. There is rarely any local redness over the affected joints. The pulse also, in contradistinction to the infectious type of arthritis, remains low (Figure 151) and does not show a disproportionate increase over the curve of temperature, as has been shown to be the case in infectious arthritis (cf. Figure 125).

Not all the cases that present symptoms of a kind such as

have just been described, whether treated or not, progress to crippling deformity. There are a certain number of spontaneous recoveries, and treatment properly planned and conscientiously carried out will cause the advances of the disease to cease in a certain proportion of the cases. As in every other condition there are always individuals who for one reason or another, and in spite of whatever may be done, progress steadily to an unsatisfactory termination.

The most extreme types of deformity which occur in this disease we are all familiar with in the almshouses and homes for incurables. In these cases ankylosis has taken place in most of the joints and the villous changes which precede them in the synovial membrane have undergone repair or have been transformed into fatty or fibrous tissue, and practically nothing remains to indicate the original process in the soft parts. Extreme rarefaction of the bone and obliteration of cartilage are the conspicuous features in these cases.

Recent investigations are tending to show a relation between the forms of arthritis classified in this book as "infectious" and "atrophic" and the chronic type of gout. These resemblances are particularly noticeable in the X-ray examination, though they may sometimes be detected clinically. There is present the atrophy of cartilage, and about the margins of the joints irregular, hard deposits may be felt and seen, similar in some ways to Heberden's nodes, and yet with the restrictions in motion which characterize the "atrophic" cases. The studies which have drawn attention to these resemblances have been carried on by Strangeways, at the University of Cambridge, England, and been confirmed in this country.

**Treatment.** The treatment of atrophic arthritis has undergone very considerable change in comparatively recent times. As has been pointed out before, confusion as to etiology and pathology has been responsible for much of the error rendering treatment ineffective. As long as the older conceptions of the nature of the disease were accepted the entire scheme of management was

made consistent with those hypotheses, the essential features of which were depletion of the patient by diminishing the amount and changing the character of the food and attempting to control the disease through the administration of anti-rheumatic remedies, principally the salicylates and the iodides. The long-continued administration of such drugs serves to disturb the digestion, impair the appetite, and render the patient poorly conditioned to combat a disease of disturbed metabolism, in which the patient instead of being starved should be fed, and instead of being kept quiet, except in the more acute stages, should have every effort made to stimulate the local as well as the general metabolic processes. No attention has been paid to the joints themselves, except to apply external lotions and ointments in the nature of counter-irritants; nothing has been done to prevent the development of deformity or to preserve the function of the joints. Therefore the treatment which is now advocated is a radical departure from what has been the general practice in the not very remote past. Dietetics has long occupied the centre of the stage in the treatment of this form of arthritis. Now that the etiology and pathology are a little better understood it seems likely that dietetics will have to give up its position to other forms of treatment, not because it is not of importance, but because it is not of the paramount importance it was formerly supposed to be. In a disease which is no more decidedly inflammatory than this atrophic type it is easy to understand that restrictions which would be appropriate in the treatment of inflammation are out of place here. The best and most sensible rule to follow is to encourage the patient to eat whatever agrees with his digestion and causes no intestinal fermentation, and urge him to increase his weight by the ingestion of a wholesome amount of digestible food, whether or not that food includes meats, starches, sugars, or fats. With regard to the use of alcohol much the same principle should govern as in the case of food. If the person is in the habit of using alcohol in moderation there can be no reason for excluding it from the diet, so far as it has any specific effect upon the disease in question. Giving small quantities of food at rather frequent intervals is probably the best

way to force the feeding of these patients, particularly if they have been debilitated by prolonged restrictions.

Mechanical treatment should be directed to the prevention of deformity in the earlier stages by the application of splints or plaster of Paris dressings and the correction of deformities and subsequent application of as simple splints as possible when deformity has taken place. This holds true particularly of the locomotive apparatus, and more especially of the knees and feet. Happily the hip joints are seldom involved. The joints of the hands and elbows do not readily lend themselves to treatment by apparatus, because it is more irksome, and accomplishes much less than in other regions. The hands, though seriously deformed, are capable of considerable functional activity and their incapacity is not of as great importance in the general treatment of the disease. The main thing that should be striven for in the joints of the upper extremity is the securing of a useable position in case ankylosis should take place. In the knees much can be done, and the importance of doing it is twofold. In the first place it improves or preserves, as the case may be, the function of the joint concerned, and in the second place such improvement or preservation has a very material bearing upon the general condition of the patient and enables him to fight the disease to much greater advantage. The most convenient and efficient form of apparatus in the milder grades of deformity before operative correction is required, or even afterwards, is the so-called "caliper splint." By its use alone the lesser amounts of flexion of the knee may be overcome, and after forcible correction of such deformities it is of great value, preventing their recurrence. Plaster of Paris can be used for this purpose also at less expense and trouble. In many cases splints may be worn at night and omitted during the day, thus permitting active use of the affected joints during the working hours, and at the same time preventing the assumption of deformed positions during sleep.

The operative procedures which are of value in the atrophic type of arthritis are those which have for their purpose the bloodless correction of deformity and those which aim to relieve the joint of

the villous thickenings which may interfere with function and consequently hinder the restoration of the joint to a more useable condition. When the knee joint for instance is flexed to as much as  $45^{\circ}$  and extension beyond that point is impossible on account of pain or mechanical obstruction, it is usually better to anaesthetize such a patient and overcome the contracture of the joints and put them up in a corrected position in plaster for a week or so, after which time the plaster may be removed and we may begin with local stimulating treatment, gentle passive motion and massage, using a caliper splint to prevent a recurrence of the deformity until such time as the joint will remain extended when unsupported by apparatus. In some cases this can be accomplished manually, but in many patients, particularly in those where subluxations and knock knee are present, mechanical aids to correction must be employed. There are various forms of genuclast devised and the one figured (Fig. 185) has been found of great assistance. As thorough a stretching as possible should be practised, so that when the instrument is taken off the knee will not recontract. Freedom of motion of the patella is of course important. The shortening of the hamstring tendons may require tenotomy. Contraction of the posterior portions of the capsule will usually stretch out by prolonged retention in as complete extension as can be obtained without the use of too great force. It is sometimes wise to rely upon this fact in the longer standing cases of flexure of the knees where the genuclast seems incapable of overcoming the contracture. When correction has been secured with the genuclast, plaster of Paris casts should be applied in a corrected position and retained until such time as the knees do not tend to relapse when they are removed for any length of time. It is desirable to splint them at least a week after the manipulation and commence massage and passive motion. When the sensitiveness is diminished the caliper splints may be fitted for day use, and the split casts worn at night. Patients should be able to stand in three to four weeks, and then be encouraged to walk with splints and crutches, and slowly to give up the crutches, then the splints, but the latter should not be permanently omitted until the patient can stand with

the knees extended without the aid of the calipers. The ideal result cannot be looked for in all cases, but an approximation to it may generally be secured.

Occasionally an arthrotomy is necessary in these cases to rid the interior of the joint of villous thickenings which tardily cicatrize. The presence of these acts as a foreign body, perpetuating a painful condition and interfering with the motion of the joint by dropping down beneath the patella or wedging in between the tibia and femur. This procedure is rarely necessary, but should be borne in mind as of possible service in properly selected cases. The description of this operation has been given in another section. (Vide Appendix.)  
Excision of the major joints in the atrophic type of arthritis has been a very unsatisfactory procedure, as union has followed where it was not desired, for example in the elbow, and has not been obtained where it was desired, namely in the knee.

In the drug treatment little can be said except by way of caution against placing great reliance upon remedies of this sort. Tonics and alteratives designed to keep up the eliminative functions of the body should be used as indicated, but great stress must be laid upon the avoidance of anti-rheumatic drugs. Particularly is this true of the two which are most in vogue, the salicylates and the iodides, the continued administration of which accomplishes but little in the relief of pain and does much harm by interfering with the digestive functions. A judicious use of aspirin in the dosage of five grains three or four times per diem does make these patients more comfortable and seems to have a less injurious effect upon the digestive function than the other salicylates. There is no specific for the disease.

As there has been considerable misapprehension with reference to the appropriate diet, so has there been in regard to the propriety of passive motion and massage. There is no question that harm can be done these patients by adding to disability and impoverishing the local nutrition of a joint by too long a continuance of conservative treatment. They certainly need local passive stimulation in place of the active stimulation which results from ordinary use,

and this can be best obtained by alternate douches with hot and cold water, mechano-therapy and massage. Baking is of considerable assistance in producing a desired local hyperæmia, and should be used in the treatment of the individual joints. The electric light baths, with either the arc or incandescent lamps, are also very effective in this way both when applied locally, and generally as in a cabinet. The use of the Galvanic or Faradic current doubtless has some therapeutic value in the way of influencing local metabolism, but probably not as much as have the other measures referred to. The value of high frequency currents has been studied at one of the Clinics in a considerable number of cases and such encouraging results obtained that we believe the method deserves a thorough trial. It might be applicable where the other means of treatment were not readily at hand. Local hydrotherapy of the sort which we have just indicated is of value, and if the facilities for carrying out such treatment in greater refinement can be obtained it will be correspondingly more efficient. Massage can be practised directly upon these joints as well as upon the muscles in the neighborhood without risk of stirring up any active process and with very great benefit to the local condition. Passive motions should be practised up to the point of causing pain. All these last-mentioned procedures, however, should not be applied to any joint in the more acute stage of the process, the stage in which the villous changes are actively progressing, as indicated by increased swelling and elevation of the surface temperature. Patients are all likely to become more or less neurasthenic and require constant incentive in order that the best results may be secured. A thorough understanding with the patient forms the best basis for treatment. Certain things can be accomplished, but they are far removed in most cases from a complete cure, and in most patients it is better that this should be understood by the patient and by all those who are to be in daily contact with him. A great deal of the success of treatment depends upon the co-operation of the patient in every detail. An atmosphere of hopefulness tempered by reason should be constantly about him and a resourceful attend-

ing physician who can give the time to the details of the case and supply the moral support is absolutely essential.

**Prognosis.** It is very difficult to give a prognosis on seeing a patient in consultation or only once or twice, — more difficult than where acute disease is in question, because so many elements enter into the matter. It is fair to say however that young persons, e. g., persons under forty years of age, provided they can put themselves in proper surroundings, and be relieved from such causes as mental or physical wear and tear, may be promised a considerable degree of improvement in all, and a cure in some cases. If they can have a nutritious diet and appropriate local treatment, with out-of-door life and exercise, the chances of securing the above results are greatly increased. If this can be done Nature will often do a great deal to repair the damaged joints. Absorption of the villous thickenings and some restitution of the atrophied cartilage or replacement of it by fibrous tissue can be expected, and with this, improved function and its attendant benefits, both local and general, will ensue.

The following cases illustrate typical instances of the type of atrophic arthritis, both as to etiology and clinical course.

**Case I.** Female; 74 years of age; married; has borne three children.

Patient lived in good circumstances, but at a period when the housewife had not only the responsibility of the home and the family, but had less help from servants than at the present day. As a girl she was never very strong and soon found the limit of her physical endurance, which however she frequently exceeded. Her mother had the same type of arthritis that she herself has. Her maternal grandmother is said to have been rheumatic, but to just which type her case belonged is not clear. Patient has one sister with hypertrophic lesions in the fingers. Otherwise the family has had no objective signs of arthritis, though several of them have complained of rheumatic pain in various joints.

She had the usual diseases of childhood, but after them she had no



serious sickness of any description. A series of abscesses connected with one tear duct caused her considerable trouble for a short time. Her children were born after she was twenty-five and were not abnormally near together in their births, over two years intervening in each case. During her pregnancies she was perfectly well, but her convalescence was always very trying and prolonged. Her household was large and her responsibilities in connection with it were considerable. About the time of the birth of her children she first noticed the early signs of her arthritis, commencing in the fingers. This was over forty years ago. Gradually year after year single joints have been involved, sometimes new ones, sometimes recurrences in joints previously attacked. In the intervals between attacks there has never been complete restoration to normal. The joints have never been red, or shown signs of acute inflammation. There was swelling, and in the hands deformities early became evident, consisting chiefly of an ulnar deflection. The wrists, shoulders, elbows, hips, knees, feet, and spine have been at one time or another involved in the process. She has never been prevented from getting about quite freely until this present attack, which has set up such an acute process in the left knee that she has been unable to move at all. At no time has she carried any fever. There has been swelling of the affected joints, but no deformities except those noted in the hands and in the feet. Her principal complaint has been stiffness in all her joints, and this has been on the increase more especially the past year. Has weighed 102 pounds; present weight, 90 pounds.

Physical examination. — Small, slightly built woman. Color good. Does not show her age; would easily pass for one five to ten years younger. Marked ulnar deflection of both hands, particularly the left. Second row of phalangeal articulations swollen somewhat and flexed upon the third row. Metacarpo-phalangeal joints are swollen; marked interosseous atrophy. Both wrists moderately stiff but without deformity. No excess of fluid in any joint. Elbows have normal motion. Shoulders are somewhat stiff. Cervical spine apparently freely moveable. Dorsal and lumbar spine not examined. Both feet show contractures of the toes due to arthritis of the second

row of phalangeal joints and some tendency toward abduction of the toes. Motions at the mediotarsal and ankle joints not much restricted. Right knee shows considerable capsular swelling and is very tender to pressure and sensitive to motion. No fluid in the joint. No redness or increase of surface temperature. Both knees can be completely extended. Left one can be flexed to a right angle. Some crepitation on motion. Hip motion on the left seems quite free.

**Case II.** Mrs. F. Age, 43 years.

Patient has been under observation for four years. When first seen she had been suffering from "rheumatism" for several years. There had been very little deformity until about three months before the first examination. The joints of the fingers, the metacarpophalangeal articulations and the knees had shown a gradually increasing enlargement. When she first came under observation there was marked villous enlargement of the above-mentioned joints and to some extent of the joints of the toes and tarsus. The patient had had a very hard life and nervous wear and tear seemed the only etiologic explanation of the symptoms. Forcible correction of the deformities which were commencing in the knees was accomplished and caliper splints were worn for some time. The swelling in these joints increased and an arthrotomy was performed, at which time the enlarged villi were dissected out. The cartilage was thinned and striated but not much eroded. During the next two years the patient became progressively worse, the hands and fingers became much deformed, the wrists ankylosed, and though the knees remained straight there was very little motion allowed. The feet were both held rigidly in the valgus position and hammer toe deformities developed in all the toes. At the present time (1908) there is no capsular thickening in any of the joints. The ulnar deflection is correctible, there is considerable hypermobility in many of the metacarpophalangeal joints with subluxation, and marked grating on motion. This is painless. Manipulation and injection of the knee joints with oil was undertaken but no benefit resulted. A

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month later one joint was opened, the patellar tendon divided, the capsular adhesions freed, which was easily accomplished, and the patella separated from the femur and the tibia from the femur, all of which were held together because of the erosion of the cartilages. The cartilaginous covering of the femoral and tibial condyles was covered with erosions of varying sizes and was thinned down over its entire extent. Four thicknesses of Cargile membrane were inserted between the bones, but it is as yet too soon to decide upon the result.

**Case III.** Miss J. D. Age, 26 years. 1908.

Ten years ago the patient first came under observation and has been constantly where she could be seen ever since. The onset was gradual and without determinable cause. All the metacarpophalangeal joints of both hands were involved. Also the wrists, knees, feet, and one elbow. Marked villous changes with ulnar deflection and luxation of the phalangeal joints as well as flexion and extreme swelling of the knees, for which arthrotomy was performed. This was the case in which bone and cartilage were found in the villi to which reference has been made in the section on the pathology of atrophic arthritis, page 297. The wrists were also involved. All have recovered except for a little permanent flexion of the elbows and some stiffness of the wrists, both of which also have been operated upon.

## CHAPTER III

### HYPERTROPHIC TYPE (SPONDYLOSE RHIZOMELIQUE). OSTEOARTHRITIS

THE term hypertrophic arthritis has been applied to a chronic constitutional disease with local joint manifestations, which may or may not be polyarticular. In most works on chronic arthritis the local signs have been classified under separate names, e. g., Heberden's nodes, morbus coxæ senilis, etc. An attempt will be made to show that all these heretofore separately described lesions are manifestations of one and the same disease.

The parts of the body which are more commonly involved are the fingers, knees, spine, hip, elbows, and feet, and in about this order of frequency. There are very few general symptoms which go with the joint lesions to which we have referred. Such as there are manifest themselves principally in the alimentary tract in the form of flatulence and constipation. It is a disease which more frequently attacks the middle-aged and elderly, and men rather more often than women, though there is not as great a difference in this respect as in the atrophic type. In men the larger joints are more frequently affected.

Hypertrophic lesions in these various joints occur in practically the same locations, and involve primarily the cartilage and that part of it which is on the periphery of the joint. The soft parts are exempt from the kind of lesions which characterize the atrophic type, and it is generally in the advanced stages of the disease only that the hypertrophied cartilage becomes transformed into bone, though both hypertrophied cartilage and eburnized bone may be found at the same time in the same joint.

**Etiology.** So far as the etiology is concerned it would appear that traumatism and exposure play an important part, much more so

than is the case in the other forms of arthritis considered in this section. The traumatism need not necessarily be a direct and violent one from the outside, but may be a mild and oftentimes unrecognizable injury which results from the ordinary occupational uses to which the affected joints are put. It is this sort of trauma rather than the wear and tear and nervous stress of life which produces lesions of this description. Infectious diseases seem to play no part in the causation of this type. Among men the greater number of instances of hypertrophic lesions occur in those whose occupation subjects them to slight but oft-repeated injuries. There is also a type which seems to follow single, violent injuries. Those among whom such traumatic conditions do not frequently occur are often the subjects of sudden and extreme changes in temperature and humidity which seem to be capable of inciting lesions of this character. It is often observed in men employed as stationary engineers and firemen, who habitually work in excessively hot places, and who for the purpose of getting cooled suddenly change their body temperature by going into the outside air. Such cases are naturally more commonly observed in winter than in summer. Another group are teamsters, who frequently become drenched with rain, and necessarily in many instances must continue their work without being able to dry their clothing. Longshoremen and freight-handlers are particularly liable to the spinal form, apparently because they have to work in exposed situations carrying upon their backs heavy loads which are often cold and damp.

Among women the disease is more common in the finger and knee joints. It is more frequently seen in those who do their own housework and are constantly subjecting their fingers to the slight but oft-repeated traumatisms of household duties. Heberden's nodes are most prominent on the thimble fingers of seamstresses who have this diathesis. The lesions which show themselves in the knees are most prone to occur in stout women who have to be on their feet a great deal, and particularly in those whose duties call them over the stairs many times. This means constant irritation to the cartilages of the knee joint, inducing an hypertrophy of that portion

of the cartilage which is on the margin of the trochlear surfaces. The attempt to maintain the body in an erect position is therefore a source of symptoms. Those who have an excess of fat are particularly likely to suffer in this way because the centre of gravity being shifted in front of the normal plane makes it easier for them to walk with the knees slightly flexed, a position which represents joint strain, and aggravates the tendency to the formation of cartilaginous nodes about the articulations.

Spinal lesions are much more common in men than they are in women. Not infrequently lesions of the elbow are noted in baseball pitchers, tennis players, and individuals who constantly strain this particular articulation in the pursuit of their occupation or sport. This is probably not always due to a diathesis, but may be simply a traumatic osteoarthritis.

Hypertrophic type of arthritis is not commonly seen in very young people. In general the average age at which hypertrophic lesions commence is later than that at which atrophic lesions are noted.

In elderly people there is a senile type in which the osseous lesions are not manifest, but in which the insertions of the ligaments into the joints partake of a thickening similar to that which is seen in the more pronounced hypertrophic changes. Arterio-sclerosis will often be found accompanying these senile hypertrophic lesions. In younger people also, symptoms are frequently observed, particularly in the spine, which are suggestive of this diathesis, and doubtless represent lesions which for some reason have not progressed so far as cartilaginous and osseous changes. They may show thickening and infiltration along the attachment of ligaments, due doubtless to disturbances in the chemical processes of the body, and also to the pull of these ligaments upon the bone.

It would be wiser therefore in grouping the hypertrophic cases to recognize among them these three classes, the early ligamentous lesions occurring principally in younger people, the true cartilaginous and osseous changes which appear in the middle period of life, and the senile changes which are on the borderland between the ligamentous and the osseous, and which occur in advanced years.

It is a matter of some interest, though of what clinical significance it is difficult to say, that the appearance of these lesions in several of the small joints or one or two of the large ones usually exempts a patient from an extensive polyarthritis of this type. Heberden's nodes frequently occur with lesions of the same character in the spine or some one of the larger joints, but it is rare to observe hips and knees, or spines and hips, or spines and knees together. Occasionally typical hypertrophic lesions may be observed in combination with typical atrophic lesions of the fingers. But in these cases it will almost invariably be found that the two types are separated in the patient's mind both as to chronology and symptomatology. The deformities and limitations in motion caused by an hypertrophic lesion in one joint may cause the development of the same lesion in a neighboring joint.

**Pathology.** The lesions of this disease have not been available for study to any considerable extent during their developmental stage. Fresh material is difficult to obtain because there has been supposed, and rightly so, to be very little reason for surgical interference in this condition, and consequently bone and cartilage have not been obtained at a time when their study would be of most value. In recent years however a few arthrotomies have been performed upon patients suffering from this disease, and we are in a position to interpret to some extent the pathologic findings.

Joints affected in this way show on opening very little change in the synovial structures. The general cavity of the joint is usually fairly normal except that in isolated spots which are associated with hypertrophy of the cartilage in the immediate neighborhood, there may be localized villous hypertrophy. In other cases the subsynovial fat is in considerable excess. This is diffuse at times, and at others is more localized. The part which is more particularly affected is the outer upper quadrant of the quadriceps pouch, and that part of the synovial membrane which is dependent from the alar ligaments. There is rarely any increased vascularity of the synovial membrane, and very rarely any excess of fluid. The cartilages are seen to be irregularly hypertrophied, particularly along the margins of the

trochlear surfaces where they shade off into bone. In the knee joint, this "lipping" is in many instances one-fourth to three-eighths of an inch in thickness. The appearance of the cartilage is normal, and not striated, as in the atrophic type. In those cases where definite osseous spurs have developed, the cartilage which is in apposition to them will often be found to contain long grooves. These lipped cartilages are sometimes covered with a thin vascular pannus overgrown from the neighboring synovia.

Recent observers have tried to identify the lesions of hypertrophic arthritis with atheromatous changes in the vessels, thus making the two processes akin, if not the same. It would be necessary in order to prove this hypothesis to show that atheromatous patients had hypertrophic lesions in considerable frequency. The writers are not in a position to pass upon this question. It does not seem to them that any larger number of the middle-aged individuals who are the subjects of hypertrophic arthritis have shown atheromatous lesions of their vessels. Dr. Osler is authority for the statement that Heberden's nodes, which are simply one of the manifestations of hypertrophic arthritis, are an evidence of longevity.

Histologically the change in the cartilage is quite marked. The lipped cartilage is shown under the microscope to be a very young and rapidly growing tissue, the cut surface of which reveals a series of cells with well staining nuclei about five or six times as thick as the cartilage normally covering the bone at that point. In appearance and arrangement it is not unlike the arrangement of cells at the juncture of the epiphysis and diaphysis in acute rhachitis. The bone itself shows no departure from normal bone tissue; the synovial membrane when considered histologically contains a larger proportion of fat tissue than the synovia of either the atrophic or the infectious type. Round-celled infiltration is much less pronounced even in the villi, which, as has already been stated, are occasionally somewhat hypertrophied in this disease. It is maintained by some observers that it is impossible to distinguish between the lesions of atrophic, hypertrophic, or infectious types from pathological appearances; that you may find any or all the changes seemingly





FIG. 152. Note the enlargements of the terminal phalanges and the lateral deviations at these joints. The cartilage in these articulations is not eroded. The enlargement is inside the capsule of the joint, and there is often a wearing away of the hypertrophied cartilage on the side toward which the deviation occurs. The enlargement is usually termed "lipping."

characteristic of one disease in either of the others. This is unquestionably true of the terminal lesions in some atypical cases, but it is not true of the acute lesions. The material available for comparative study at the time when the lesions of the three forms of

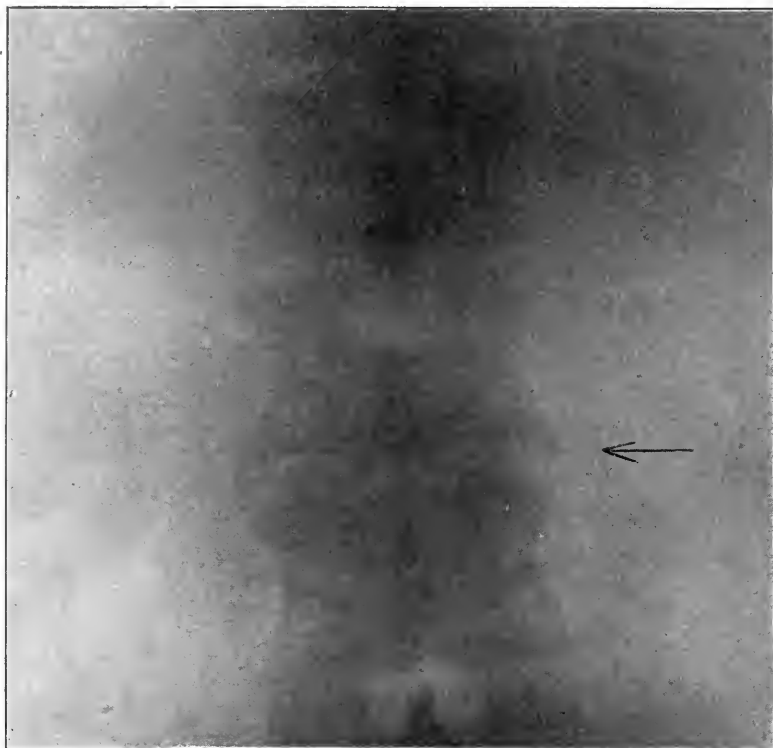


FIG. 153. This illustrates one of the sharp lateral spurs which may cause acute pain from pressure and are occasionally demonstrable in a skiagram. The arrow is directed toward a sharp spicule of bone projecting from the interior surface of one vertebra directly into the intervertebral disc.

arthritis are undergoing development has not always been at hand. There is no question that the terminal lesions of all three diseases may have some resemblances to one another, though very few, but few if any which may not be distinguished by a careful consideration of the history and clinical course which led up to the conditions found. Furthermore, reliance does not have to be placed upon an examination of the pathological lesions for diagnostic purposes, and there-

fore material is not often obtained for study during the developmental stage of the lesions; but when it has been thus obtained it has been confirmatory of the opinion that hypertrophic arthritis is a pathological entity as well as a clinical one, and is not related, as some English writers would have us believe, to the type here described as atrophic. Those who maintain that there is such a relationship believe that the hypertrophic lesions are simply the chronic stage of the atrophic.

The erosions which may be seen in some cases of the hypertrophic type are mechanical erosions, partly due to the gouging out of cartilaginous tissue by osseous spurs on a neighboring part of the joint, and partly, in the immobile joints, to the focalization of pressure upon one portion of the trochlear surface. They are certainly not the kind of erosions which one observes in the atrophic type, in which the cartilage is thinned until it becomes parchment-like or entirely absent. In the eroded areas in the hypertrophic type the cartilage is eburnated, and bare bone is not exposed at the base of the erosions, however deep they may be. The erosions of infectious arthritis have about them inflammatory tissue which conclusively establishes their character. In neither of the other forms are such inflammatory deposits to be found about any erosions.

In the atrophic type there may be present certain signs of hypertrophy. The explanation of this seems to lie in the fact that during remissions in this disease there may be attempts at repair which take the form of osseous spurs.

**Clinical course.** This hypertrophic type, as has already been intimated, has very little constitutional disturbance to mark its commencement. The patients will usually be found to have developed a very considerable lesion before they have many symptoms to show for it. The pain which is associated with the development of the osseous changes is usually of mechanical origin and is not commonly elicited except by traumatism to the affected joint or by attempts to move the diseased articulation through an arc of motion greater than the cartilaginous changes will permit.

The onset and development is very insidious and slow, several

years oftentimes being occupied in the production of lesions of any considerable extent. Commonly the patients complain more of the disability which is caused by their disease than of any actual physical discomfort which it occasions. The disease is one which is very largely self-limited, especially in the smaller joints. The process, when it quiets down, leaves practically no disturbance behind except the bony enlargements, and these in themselves, unless they are of sufficient magnitude to restrict mobility, do not cause much trouble. As a rule, the patients are pretty comfortable when they are quiet, indicating that use of the affected joints is a factor which determines very largely the painful symptoms within the articula-



FIG. 154. Illustrates the deformity which may occur in hypertrophic arthritis. This leg could not be extended beyond the point shown in this cut. Flexion was possible to a normal degree.

tion. The lesions in the locomotive apparatus, when they cause any considerable degree of deformity (Figure 154), commonly produce permanent lameness, but if the patients are careful in their use of the joints and keep them properly protected the lameness need not be of any material hindrance to them or cause them much annoyance. As has been stated the general health of patients who have this disease is usually little affected, although the bad cases sometimes suffer so much pain that they are for the time being somewhat debilitated. Digestive troubles seem to be the only factors outside the joint lesions themselves which are of any significance. Flatulence and constipation are quite common complaints, and

patients frequently remark that their joint symptoms are exaggerated if they allow themselves to become costive. Distress after eating and headache is also occasionally a cause of complaint.

### SPECIAL MANIFESTATIONS

It seems desirable to consider briefly the special lesions of this disease, inasmuch as they have been described heretofore under separate headings. That they are all the same is readily proven by a study of the clinical aspects of the different manifestations, and also by an examination into the pathological histology of the lesions produced.

**Spine.** In the spine, as is well shown in the illustrations, "lipping" (Figures 155, 156, and 157) of cartilage occurs along the margin of the individual vertebræ and frequently overlaps the adjoining bones in whole or in part. The spinal ligaments may also become affected by the process and in some instances a plastic material seems to be poured out over the anterior portions of the bodies of the vertebræ, effectively anchylosing the bones involved. The irregular distribution of lipped cartilage accounts for some of the clinical signs noted in patients suffering from this type of arthritis. The common complaint in the spinal form of the hypertrophic type is of pain referred to the region of the spine involved and usually peripherally from that point to



FIG. 155. Note the location of the plastic deposit on the sides of the vertebræ close to the injuncture. Note the extension of the process in some cases out upon the ribs.

the distribution of the nerves which have their exit from the vertebræ concerned in the process. (Figure 157.) This seems to be due to a deposition of this plastic material about the foramina out of which the posterior nerve roots emerge. The pain is most commonly unilateral, though it may be bilateral. The usual seat of disease is in the dorso-lumbar spine, and pain is referred to the



FIG. 156. Note the plastic material deposited upon the surface of the vertebræ and overlapping the line of demarcation between vertebral bodies. This deposit has in some cases extended out upon the ribs. Note that one side of the anterior surface is free, whereas the other is extensively covered with this deposit.

leg or foot on one or the other side. The next most common region involved is the cervical, with the referred pains usually localized in the arm and hand of one side. The patients are also frequently aware of a restriction in the mobility of the trunk, and upon examination this restriction is seen to exist sometimes in one direction, sometimes in another, and occasionally in all. It is probable that the localization of hypertrophic lesions in those portions of the column where there is normally greatest motion is due to this very fact,—the trauma of motion being a factor in the localization. Very commonly, however, one observes a greater restriction in one direction than in another (Figure 158), and will also detect, if he carefully

notices, that lateral mobility of the column may take place at a higher level on motion toward one side than toward the other. Also occasionally, upon making these patients bend forward, this motion is accompanied by a rotation of the trunk in one direction or another, or by a lateral deflection. All these phenomena

are to be explained by the fact that the bony deposit is irregularly distributed over the vertebral bodies. Where it is greatest there is the least motion, and if the deposit is so situated as to conflict with two of the possible spinal motions at the same time, a complicated action of the column may be expected. There is no tenderness along the nerve trunks (pressure upon which causes peripheral pain in true neuritis), so that although the region most commonly affected is that which is supplied by the sciatic nerve the symp-



FIG. 157. A lateral view of the upper cervical and dorsal column showing the plastic deposit in the neighborhood of the foramina, out of which the spinal nerves emerge.

toms are not those of a true sciatica. One notices in these cases an atrophy on the side where the referred pain is situated, and an atrophy which involves the muscles of the thigh particularly, but also to some extent those of the calf and buttock. This atrophy may often be appreciated only by palpation. It is suggested that possibly there may be some nerves which have to do with supplying the nutrition of the subcutaneous tissues, which run in

the posterior nerve roots, and that pressure upon these causes atrophy, as pressure upon the sensory nerves causes pain. It would not seem that the atrophy could be explained on the ground of lack of function or disuse, because even if the patients have a considerable degree of pain they are usually up and about without limp,



FIG. 158. Represents the maximum amount of lateral mobility in a case of low dorsal hypertrophic arthritis. Note the greater freedom of motion in the left-hand figure and the fact that it takes place at the usual location of lateral mobility in the spine. In the right-hand figure maximum lateral mobility takes place higher than normal and to a less complete degree.

and it is scarcely conceivable that they would use one leg less freely than the other when no device for the restriction of motion is employed. In the involvement of the cervical spine (Figures 160, 161, 162, and 163) similar restrictions in motion are observed as well as similarly distributed peripheral pain and atrophy. There is oftentimes in these cases a very considerable degree of deformity present (Figure 164) consisting of lateral deviations of the column or



flexions of the column as a whole, without any sharp angular kyphosis. This however will commonly disappear under treatment.

Patients with hypertrophic lesions are very apt to complain a great deal of the cold. This complaint is a subjective one, as



FIG. 159.



FIG. 160.

FIGS. 159 and 160. This series of figures illustrates the position in which the head was held in a case of hypertrophic arthritis of the cervical spine, and the amount of rotation which was possible in either direction.

objectively the parts complained of are as warm as on the other side. Numbness and paresis have been observed in two cases of this sort in the cervical region. In both cases recovery was complete.

**Knees.** The hypertrophic changes which attack the knee joints may involve the tibia, the femur, and the patella. (Figure 165.) In the patella bony spurs are naturally most frequent around the margin of the cartilage covering the inferior surface of the patella and also project from those parts of the patella to which the quadriceps tendon is attached upon one side and the patellar tendon upon the other. Sharp bony spurs are oftentimes seen in this situa-



FIGS. 161 and 162. Photographs illustrating the maximum lateral bending possible in a case of hypertrophic arthritis of the cervical spine. The symptom for which this patient sought treatment was pain down the right arm and hand accompanied by numbness and prickling.

tion projecting directly into the tendons. On the femoral condyles lipping of the cartilage occurs at the margin of the trochlear surface. On the tibia the changes show along the edge of the articular surface of the bone, projecting sharply forward and almost always on the anterior aspect. When these tibial and femoral spurs become of considerable size they act as a mechanical obstruction to full extension of the leg. At times large pieces of this hypertrophied cartilage become detached and move about more or less freely in the knee joint. They are palpable through the skin in most instances, are tender to deep pressure, and may cause a crepitation to be felt and sometimes heard. The presence of these hypertrophied cartilages usually causes permanent flexion and more or less restriction in motion.

**Hip.** The name *morbis coxæ senilis* has been applied to hypertrophic changes which occur in the head of the femur and the acetab-

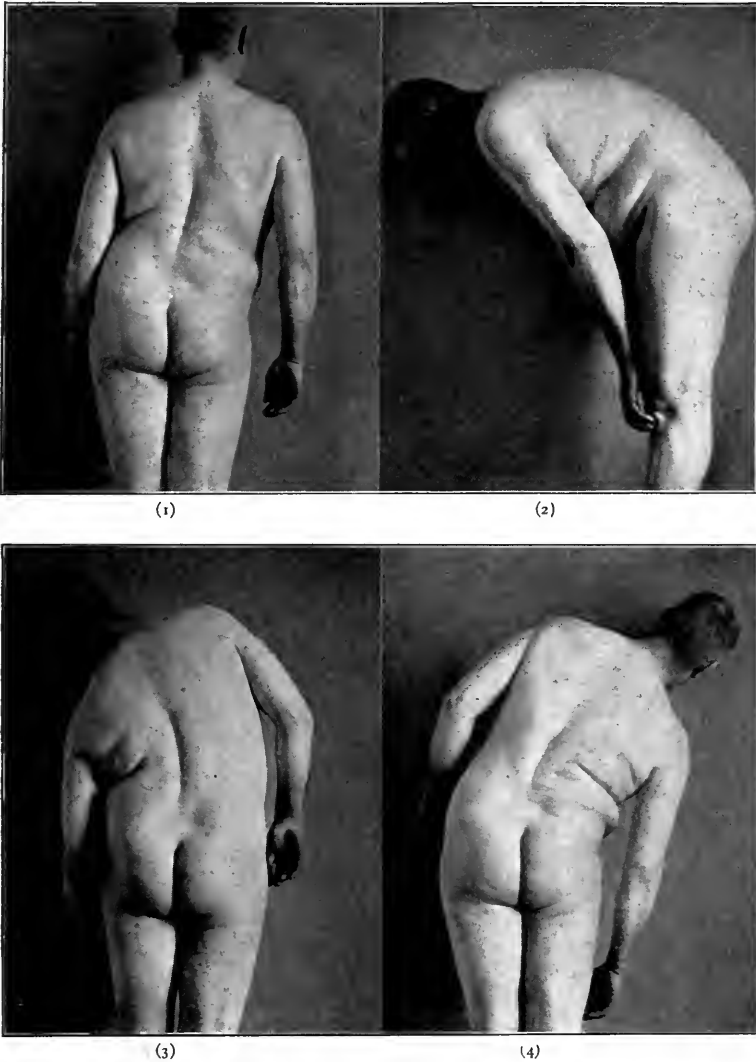


FIG. 163. In (1) note the lateral list to the right; in (2) his maximum flexion; and in (3) and (4) the differences in side bending to right and left.

ulum and prevent free movement of the femoral head within its socket. The cavity of the acetabulum is not diminished in depth,

but is, on the contrary, much broadened, so that its upper lip overlaps (Figure 166) more or less completely the head, and in some instances actually grasps it and a part of the neck of the femur. In this situation the irregularly shaped deposits of cartilage and bone

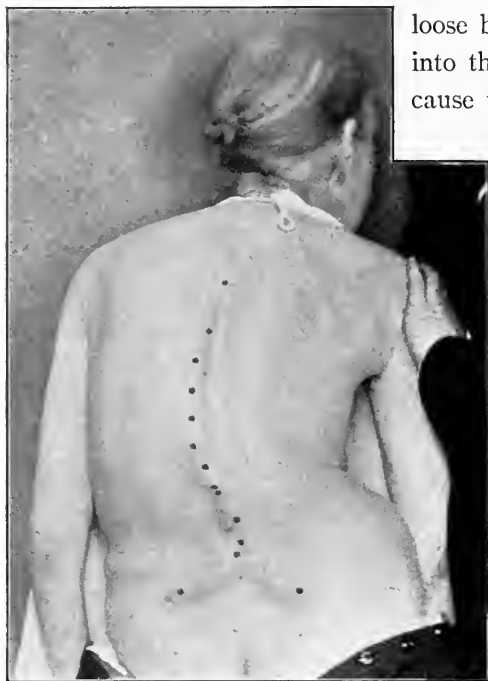


FIG. 164. Note the rounded kyphos and the lateral deflection without rotation. The spine was entirely immobile from hypertrophic deposits.

sometimes become detached and loose bodies may be displaced into the cavity of the joint and cause trouble from locking the

articulation. A patient whom the authors now have under observation presents this condition. There has been great pain, especially in certain positions of the joint, and walking or weight-bearing has been impossible without a spica to hold the thigh firmly. X-ray shows marked lipping of acetabulum. Motions are restricted in abduction and inward rotation only. Occasionally a very coarse

crepitation can be felt accompanied by very acute pain when the limb is being manipulated. Further manipulation will seem to ease the pain, apparently by dislodging the detached "mouse" from a position where it caused pain.

Clinically the symptoms of this form are very slow in their development. Sometimes the first thing that the patients note is an inability to get at their feet to put on their shoes. This disability must have been a long time in development, and yet very commonly few symptoms are associated with its production. When these pa-

tients are examined there is usually noted an atrophy of the thigh and calf, the motions at the hip joint are restricted mechanically, not



FIG. 165. Note the squaring of the patella and the lipping of the cartilage on the superior and inferior borders of the patella where the tendon of the quadriceps extensor is inserted. Also the hypertrophy of the trochlear surface of the femoral condyles.

by muscular spasm. The earliest signs of the trouble are indicated by the manner in which flexion of the thigh is restricted. Flexion

cannot be accomplished unless accompanied by abduction, while rotation of the head of the femur is restricted very markedly in both directions. Hyperextension of the leg is usually prohibited.



FIG. 166. Note the enlargement of the head of the femur and the irregular shape of its upper portion. There is also "lipping" of the acetabulum.

Pain is associated with this form, and a marked limp on walking. The foot is also rotated outward and there is often a slight amount of shortening due either to flexure of the neck of the femur, change in the size of the acetabulum, or "mushrooming" of the head of

the femur. The essential features however are the peculiar limitation of flexion of the thigh and an association of abduction and outward rotation with this. These motions are not accompanied by muscular spasm unless there be acute joint strain, but are restricted only by the presence of the hypertrophied cartilage or bone. The region of the trochanter and neck of the femur show some thickening in these cases. In the long-standing cases the top of the tro-



FIG. 167. Note the hypertrophic spurs on the astragalus, lower end of tibia, os calcis, and cuneiform.

chanter may be on or slightly above the Roser-Nélaton line, for the reasons above stated.

**Feet.** Hypertrophic lesions in the feet may occur on any one of the tarsal bones; more commonly spurs project from the neck of the astragalus and overlap the scaphoid, or from the scaphoid and overlap the internal cuneiform. (Figure 167.) Such spurs interfere with the finer motions of the ankle, particularly those which take place at the medio-tarsal joint. They are very painful and are subject to

increase from pressure of the shoes. A similar node often forms in the dorsal surface of the distal end of the first metatarsal.

**Elbow.** In the elbow this hypertrophic type commonly attacks the olecranon process (Figure 168), and by depositing cartilage and bone about the upper portion of this interferes materially with the ability to extend the elbow. It also attacks the coronoid process of the ulna and in a similar manner interferes with flexion of the joint. As in the hip, the restriction which the presence of these bony spurs causes is mechanical and gives rise to no spasmodic reflex action unless great irritation from excessive use has occurred.

**Hands.** Heberden's nodes are the lesions most readily demonstrable clinically. The hypertrophied cartilage Figure 152 is situated along the margins of the articulating surfaces of the terminal phalanges. Rarely do we see such lesions in the joints nearer the carpus, and very rarely indeed do we see them in the carpus itself. They probably are more commonly associated with the terminal row of phalanges because these joints are subject to the greatest amount of traumatism, occupational or otherwise. The effects of the irregular deposition of bony material about the phalangeal articulations is well seen in the deformities which result in these joints from this disease in marked distinction to the deformities of the atrophic type in which luxations and subluxations predominate. We find in the hypertrophic type that lateral deflections of the terminal phalanges, or flexions alone, are the chief deformities. In other words, the irregular deposit of cartilage and bone pushes the terminal phalanges to one or the other side, and causes an atrophy on the side toward which the deflection occurs.

The above-mentioned situations cover practically all the articulations which are affected by this type in any considerable frequency.

**Treatment.** Inasmuch as the constitutional disturbance in this disease is slight, and in most cases none at all, very little attention need be paid to that phase of treatment. It seems probable that the affection is one associated with faulty elimination. It is therefore desirable to favor elimination in every way. The skin being one of the channels for excretion, care should be taken to keep it in good



condition through stimulating baths or hydrotherapy, salt rubs, and massage, with as much exercise as may be taken without irritation



FIG. 168. Lateral view of elbow showing hypertrophic deposits on the trochlear surface of the humerus; also some enlargement of the olecranon process.

of the affected joints. The bowels should be kept free, for example by the ingestion of some such drug as the phosphate of soda, which

also favors the excretory function of the kidneys. An efficient method of administration is in a glass of hot water half an hour before meals. Oftentimes these patients suffer from flatulence, which is best relieved by the bicarbonate of soda. Olive oil taken in tablespoonful doses once a day is a good mild laxative which seems to be of value in these patients. It may be that digestive disturbances represent a source of auto-intoxication which accounts for the metabolic disarrangement.

Up to recent times local treatment has been much neglected, but it is really one of the most important features of the whole matter. The methods employed in the management of the affected joints are directly opposed to those accorded to the infectious and atrophic forms of joint disease. Protection of such character as to prohibit the extremes of motion is desirable. Restriction should be confined to the prevention of such motion as would bring the hypertrophic nodes into apposition with one another or crowd them against parts of the joint not so involved, for inasmuch as traumatism plays an important part in the stirring up of the process, so also will it tend to perpetuate and increase lesions already existing. It may also serve to chip off from the articulating surfaces portions of the hypertrophic nodes, setting them free in the joint and thus causing much trouble from interference with motion.

Treatment consists in the prevention of deformity, its correction when existent, and the removal in certain selected cases of the bony spurs which are a source of irritation to the joint as well as a cause for interference with motion. There is no assurance however that these spurs may not recur. Massage, which is permissible in many of the other forms of joint disease, and is in fact desirable, particularly in the atrophic type, may be a pronounced evil in the treatment of hypertrophic lesions. Great caution should be observed in avoiding any massage to the lesions themselves. When directed to the muscles between the affected joints it is of decided value. Fixation in plaster of Paris or leather splints relieves the patients of painful symptoms attendant upon over-use of the joint, and tends to overcome the deformity by enabling some shrinkage to take place in the

hypertrophic nodes, and also by setting at rest any reflex spasm which has resulted from the stirring up of the joint. Fixation should be applied to the spine, hip, knees, elbow and feet by means of leather splints, appropriately fashioned over plaster models or by simple plaster of Paris dressings. For the fingers, metacarpus and wrists tin splints made in the form of a gauntlet reinforced with wire so that they may be bent at will, afford a practical method of applying fixation. For the fingers alone stout and loosely fitting kid gloves reinforced on their palmar surface by light steels are useful. These various pieces of apparatus form most effective means of controlling painful symptoms, of lessening deformity, and of restoring the parts to as close an approximation to normal function as is consistent with the existence of such a disease. The use of crutches in lesions of the locomotive apparatus during the more acute stages is often indicated. The operative treatment must be reserved for carefully selected cases and should only be employed at a time when the disease is not acute. Manipulative measures which are of so much service in the correction of the deformities of the atrophic type or in the treatment of the adhesions which commonly succeed inflammatory processes in the joints are for the most part contra-indicated in this disease. Arthrotomies performed for the purpose of removal of bony spurs in the quiescent stage are occasionally permissible, more especially in the elbow joint. The reason that they are particularly applicable to this articulation is that the surfaces upon which the principal lesions occur are so small that one can be fairly sure of being able to remove enough of the obstructing spur to enable greater mobility of the joint. In the knee joint very occasionally is surgical interference permissible, and when resorted to it should usually be for the purpose of ankylosing the joint. Excision of hip joints for the hypertrophic type of arthritis has been performed, but seems hardly justified by the results. The writers have excised two hips for this purpose, with a fibrous ankylosis in one case, without relief of symptoms; in the other case symptoms were relieved, but a poorly functioning joint was the result. Osteotomy for the purpose of correcting deformity and thus lessening the joint strain

should be favored in many cases. Altee of New York devised an operation which in the few cases tried has secured a long ankylosis and functionally satisfactory results.

The dietetic treatment of the hypertrophic type of arthritis offers at the present time no satisfactory results. More must be known of the physiological chemistry of the body and of the methods of assimilation of food before we shall be in a position to effect any benefit by this means of treatment. Heat applied to the joints brings considerable comfort to these patients and the method of its application is capable of considerable variation. Dry heat applied by baking or some similar device has proved very satisfactory in the authors' hands; cabinet baths, hot water stupes, hot sand baths and electric light baths,—all have their place. Hydrotherapy has not seemed to be of as great service in the hypertrophic type as in the other forms. These patients are more comfortable when their affected joints are very warmly clothed.

**Prognosis.** Because of the tendency of this condition to be self-limited, and because of the lack of seriousness which in the vast majority of cases attends the progress of the disease, one is enabled to give a more satisfactory prognosis than in many forms of joint involvement. In the hands and feet it is commonly safe to say that with proper management the painful stage can be much ameliorated and shortened. The osseous deformities will necessarily remain, but will probably not interfere with functional use of the part involved nor cause the continuance of pain. In the spine it is likely that some permanent restriction in motion will remain, but the painful stage will most certainly pass, and the rapidity with which it disappears can be very materially affected by treatment.

The prognosis is worse in the hip and knees than in any other part of the body. Particularly is this true with regard to the hip; greater disability can ensue from interference with hip motions when produced by this form of disease than in almost any other way. When both hips and the lumbar spine are involved at the same time a serious condition exists so far as the capacity of the individual to get about is concerned. The duration of life is not affected.

Under proper protective treatment, carried out for a sufficient length of time, one can safely promise three things to his patients, — a decided amelioration in the severity of symptoms in consequence of treatment, the preservation of a sufficient amount of mobility in the affected joints to permit of fair function, and the shortening of the course of the disease.

**Case I.** Mr. G. N. May, 1903. Age, 35 years.

Patient has noticed trouble with his right shoulder after throwing baseball. This was four days before he was first examined. The motions have gradually improved so that they became quite free. For two years before this however he had a "tennis elbow," caused by playing court tennis, and during this time has had quite marked restriction of the motions of this joint. He is very fond of outdoor sports and has found that it was very difficult for him to row since he has had this trouble. A short time ago in attempting to jump from the boat he caught on a rope and the elbow received a severe wrench. This produced a marked increase in the stiffness of the elbow and also aggravated his pain. Driving his automobile has also caused him so much discomfort that he has had to give it up.

Physical examination. — Strong, healthy appearing man. Right elbow flexed to about  $25^{\circ}$  permanently and cannot be carried beyond a hundred degrees in flexion. There is some swelling about the joint. Pronation and supination nearly normal. X-ray shows evidence of hypertrophic lesions along the olecranon and coronoid.

After keeping the arm quiet in a bandage and giving up the use of it the soreness has disappeared to some extent, and motion is perhaps slightly improved. Operation however was advised, and in June, 1903, an incision was made over the internal condyle exposing the interior of the joint, and from the internal aspect of the olecranon and coronoid several osseous nodes, which were quite dense in character, were removed. The immediate effect of this was to increase the amount of flexion and extension at the elbow. He made an uninterrupted recovery and the gain in motion which was secured at the time of the operation was a permanent gain. The

functional use of the arm has been very much improved, and that improvement has remained permanent through a period of four and one-half years since the operation, and the patient regards himself as perfectly well.

**Case II.** Mrs. W. Age, 60 years. March, 1902.

Patient was fairly well until November, 1901, when she first suffered from "rheumatism" in the knees. Since then has been confined much of the time to bed and has been unable to go anywhere necessitating climbing the stairs. General health very good.

Physical examination. — A large, healthy woman. Both knees swollen and have well-marked osteoarthritic nodes along the lower margins of the femurs. Synovial membrane much relaxed. The right knee lacks 30° of complete extension. Left knee can be completely straightened.

After a short treatment in strapping, two leather leg splints were made for the patient and with these she has been able to get about the house very freely and has had practically no discomfort in walking while using them. Her ability to go over the stairs gradually returned and at this date, five years after the patient was first seen, she is able to move about much more freely than at that time.

**Case III.** O. F. S. 56 years of age. March 28, 1907.

Complaint. — Pain in getting up from sitting position.

Duration. — 4 to 15 years.

When he was a young boy had acute rheumatism which disappeared from all the joints except the right hip and the left foot. Ten years after this attack the right hip dislocated, but he has been able to work and be very active all his life up to about a year ago, but since then he has been suffering so much that he has been unable to be about much. Most troubled when he gets up in the morning until he has moved about some. Creaking in the hip is plainly audible. No pain when he is at rest. No family history of rheumatism. When he was a boy and had his first attacks he was laid up for two or three months at a time with hip trouble.

Examination. —In good general health. Right hip stiff; almost no motion;  $15^{\circ}$  permanent flexion;  $40^{\circ}$  permanent abduction. Slight yielding with leg in some positions and this is attended by creaking and snapping. Considerable thickening around trochanter. Legs are actually of same length, but practically right is  $3\frac{1}{4}$  inches shorter than left.

X-ray taken. —Shows typical hypertrophic lesion about the hip joint.

April 16, 1907. — Patient was operated upon to-day under ether. An oblique osteotomy through the trochanter was made, the femur divided, and the leg put up in slight flexion and slight abduction. In this position legs were practically the same length.

April 23, 1907. — Spica bandage removed and a new one applied, the amount of abduction being somewhat increased.

May 25, 1907. —Up on crutches to-day and several steps taken.

June 15, 1907. — Left Hospital. Wearing spica.

July 12, 1907. —Since leaving the Hospital patient has been going about without crutches. The strength of the leg seems to be returning.

September 28, 1907. —Progress has been uninterrupted until recently, when he has developed an osteomyelitic lesion of the left ankle. This was operated upon and considerable pus evacuated. Recovery has been uneventful.

September 19, 1908. — Patient is in excellent condition. Walks with comparatively little limp and claims that the affected leg is the stronger of the two and for demonstration is able to jump and run about the room surprisingly well.

## CHAPTER IV

### LIPOMATA

FAT as a cause for arthritic symptoms is beginning to receive more and more attention. Physiologists have been studying fatty metabolism very extensively. The origin and methods of distribution of adipose tissue are better understood than formerly. Anatomical study has shown the existence of fatty accumulations within normal joints in situations where they may be of pathological significance. Pathology has revealed the presence of it in tissue removed from articulations which have been the subject of chronic inflammations. More careful clinical study of joint diseases is enabling the surgeon to recognize certain combinations of symptoms as pathognomonic of lipomata. In view of all this newly acquired knowledge it is proper to attempt a classification of the types of joint lipoma which are commonly found.

Anatomically, fat is a normal constituent of the synovial membranes. It provides the "filling" upon which the synovial membrane rests. Through it ramifies a certain amount of fibrous tissue. There are parts of the synovial surfaces where more fat is deposited under normal conditions than is found in other parts of the same membrane.

Individuals also vary in regard to the amount of adipose tissue which they possess, not only subcutaneously throughout the body but in the joints as well.

It more frequently shows itself in such large articulations as the knee, and here the greatest amount of interference with function is to be expected. In the tendon sheaths, particularly those about the ankle, the peroneals and posterior tibial, we frequently find fatty fringes which clog the motion of the tendon in its sheath, causing acute pain when the growth happens to be caught between the tendons themselves when enclosed in a common sheath or between



the tendon and its sheath. Recently one of the writers removed from the margin of the long peroneal tendon a series of small tag-like bodies seemingly fatty in character and associated with an excess of fat within the tendon sheath. A histological examination of these showed the evidence of frequent traumatisms in areas of telangeiectasis. (Vide article by Legg, Boston Medical and Surgical Journal, July 16, 1908.)

**Case I.** Mrs. A. Age, 38 years. Entered Hospital Clinic December, 1905.

Complaint. — Both feet.

Pain below both outer malleoli had come on gradually and progressively increased. Is aggravated by walking; disappears when recumbent. Prolonged use of the feet in walking or standing is associated with a swelling about the external malleoli. There has been no injury and patient has had no symptoms referable to her joints.

Physical examination shows a stout woman with a considerable excess of subcutaneous fat all over her body.

Both ankles indicate some filling in of the fossæ below and behind the external malleoli and a prominence of the sheath of the peroneal tendons which is more than normal. Motions of the ankle joint are free. Inversion of the foot causes some discomfort in the region complained of above. Deep pressure over the peroneal tendon sheaths is also painful.

X-ray is negative.

Exploratory operation advised.

Six weeks later, under ether, an incision was made parallel with peroneal tendon sheaths about six cm. in length. The tendon sheaths were opened and a fringe-like mass of yellow fat protruded from the incision in the sheath as though it had been forced out under tension. This seemed to come from the serous lining of the sheath, close to the os calcis and projected out from between the peronæus longus and brevis tendons. The same condition was present on both sides. This tissue was dissected out thoroughly and the peroneal sheaths closed with silk. Convalescence was unevent-



FIG. 169.

FIGS. 169 and 170. These illustrations indicate the situation of the normal fat pads in the knee joint, the hypertrophy of which gives rise to symptoms within the joint. Observe the fat pad between the top of the patella and the upper boundary of the quadriceps pouch. In this situation there is frequently a considerable amount of fat which may become hypertrophied giving rise to the "solitary" lipoma of Koenig. Note also the fibro-fatty hypertrophy of the alar ligaments in that portion of the joint which is below the patella.

ful and in four weeks the patient was walking painlessly and has continued to do so ever since.

In the fall of 1906 she returned to the hospital complaining of pain in both knees but particularly in the left. This was present only when she was on her feet; was referred to the inner aspect of the knee joint, below the patella and to some extent to the upper outer quadrant of the quadriceps pouch. She complained of a feeling of distention of this pouch, with throbbing sensations particularly when she had been on her feet a very long time and she experienced an occasional slip or "catch" in the joint as though something was caught between the bones which suddenly slipped out. This slipping was accompanied by pain but by no objective symptoms.

On examination, the knee was found to be moderately but symmetrically swollen and this swelling seemed on palpation to be confined to the synovial membrane. Below the patella and on either side of the patellar tendon was considerable

swelling due to thickening of the alar fringes. In the upper outer quadrant of the joint was a moveable tender mass which evidently represents an accumulation of fat in the subsynovial region. Patient was advised to have this removed.

In December, 1906, she entered the Hospital and an incision was made over the outer aspect of the knee joint, 8 cm. in length, and the capsule of the joint was opened. The synovial membrane was very



FIG. 170.

thin. It was almost impossible to know when it had been penetrated. A large sessile yellow accumulation of fat was found in the upper outer quadrant of the joint, situated subsynovially but protruding into the articulation. A smaller mass hung from the inferior border of both alar ligaments and differed from that in the upper part of the quadriceps pouch only in containing rather more fibrous elements than did the one first described. Both of these were dissected out and convalescence was uneventful except that the patient, who

was a very neurotic individual, would not permit the passive manipulations of the knee which were essential to the restoration of function and it was necessary to manipulate the joint under an anæsthetic four weeks after the operation in order to secure motion.

**Case II.** Miss S. Age, 46 years.

This patient was a nurse, from one of whose knees a large lipoma of the diffuse kind was removed, and her case is cited in this connection because of difficulties in after-treatment. It occupied the upper outer quadrant of the knee joint, was very extensive, necessitating a very thorough dissection of the serous membrane of that part of the joint. The patient was very hypersensitive and when

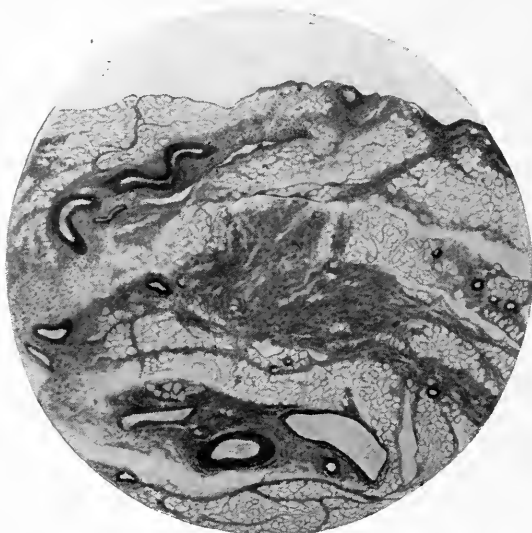


FIG. 171. Microscopic drawing from a section of a lipoma due to the degeneration of a joint fringe. Note the numerous blood vessels and the great amount of fibrous tissue.

forceful manipulations were commenced without removal of stitches it was very difficult for her to stand the pain, and though progress was being made and doubtless would have been attended with the usual success in such cases, she developed a pleurisy, high temperature, and seemed likely to have pneumonia, though she did not

have the objective physical signs of that disease. Treatment of a manipulative character had to be suspended, however, for over three weeks and at the end of that time she was in such a used-up condition that it seemed inadvisable to attempt further forceful

manipulations and it did not seem proper to give her another anæsthetic even had she consented to its administration, consequently nothing but massage and passive motion on the part of the patient was attempted.

Operation took place in April, 1904, patient was examined October 6, 1906, and reported that she had been at work nursing for the past two years and had had no difficulty with the knee, after the first six months succeeding operation, of sufficient

degree to prevent her from following her occupation. By persistent passive motion and massage she has succeeded in securing normal motion in the joint.

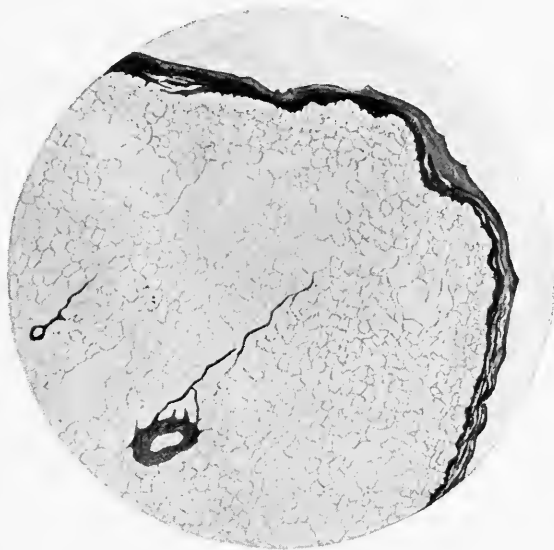


FIG. 172. Microscopic drawing made from the ordinary subcutaneous lipoma. Note absence of much fibrous tissue in the tumor, the very definite fibrous capsule which surrounds it, and the scarcity of blood vessels. Contrast with Fig. 171, p. 354.

There seem to be three distinct types of joint lipomata, based upon three distinct etiologic factors. First, traumatic or static causes; second, fatty infiltration; third, fatty degeneration.

It may not be strictly accurate to make the first of these divisions, though defects in the statics of the body unquestionably produce synovial changes which are partly fatty and partly fibrous. (Figures 169 and 170.) In other words they cause an hypertrophy of the adipose and connective tissue elements which are present in the normal synovial membrane, and the result of this is the production

of a growth within the articulation which is more fatty than it is fibrous in appearance. (Figure 171.)

In the second class of cases there is an infiltration of the sub-synovial tissue with a greater amount of fat than is normally present. This is brought into the neighborhood of the joint from without, and is deposited chiefly in individuals in whom there is evidence of an excess of fatty tissue throughout the body. On opening such joints (Figure 172) the synovial membrane is extremely thin and oftentimes one scarcely knows when he is within the joint cavity. The excess of fat is in the subsynovial tissue and its presence in this region seems to attenuate the synovial membrane and pushes it ahead of it, invaginating it, as it were. Even when the finger is clearly inside the joint cavity the yellow subsynovial fat seems to be free within the joint, though in reality it is separated from the joint cavity by a thin serous layer.

In the third class are all those cases where the synovial membrane has been injured by toxic agents, the products of the various inflammations which are capable of attacking the joint itself. The early stages of the inflammation caused by these toxic materials is that of round-celled infiltration. The connective tissue normally present is irritated and proliferates in response to the irritation. As this process ceases there is less and less round-celled infiltration and the enlarged villi become transformed into fat. This is a process of degeneration beginning in the tips of the villi and extending back to their bases. One often sees in the same joint these degenerations in various stages of advancement. Adjoining villi will present conditions varying all the way from pure fibrosis (Figure 173) on the one hand to a more or less complete fatty degeneration (Figure 174) on the other.

Symptomatically these conditions have certain features in common, and yet there should usually be very little difficulty in the recognition of the different types of lipomata. In the first class, i. e., the one in which there are usually static defects, the knee joints are most commonly affected. Occasionally direct though trifling injuries to the joint are caused from without. These may give rise to

very little disturbance at the time but gradually the patient notes the articulation becoming more or less stiff on rising from a sitting posture.

The explanation of this condition offered by Hoffa is that the extra-articular fat invades the joint through the injured synovia.



FIG. 173. Illustrates the fibrous arborescent fringe. Contrast with Figure 174, in which fatty degeneration has taken place.

FIG. 174. This cut demonstrates the reason for the term "arborescent" being applied to villous changes occurring in inflammatory arthritis. Note also the fatty degeneration of the tips of some of the villi.

### Case III. Female. Age, 30 years.

The tumor here shown (Figure 175) was removed from the right knee joint of a young woman, having caused more or less disturbance in this joint for twelve years. She was hooked by a cow over the inner side of the knee twelve years before, and ever since that time, though she was not laid up for any considerable period when the accident happened, she has had slipping sensations in the joint, frequent attacks of swelling and disability, and has been unable to take any very marked exercise on account of the liability of irritating the synovial membrane and producing uncomfortable symptoms.

On examination the tumor was distinctly palpable; was semi-solid in consistency; could be moved to a certain degree, was not especially tender to pressure and was situated on the inner aspect of

the knee about opposite the line of the articulation when the leg was extended. It filled up the fossa ordinarily seen on the inner aspect of the joint. It was removed easily through a lateral incision and was seen to represent an hypertrophy of the alar ligament on the

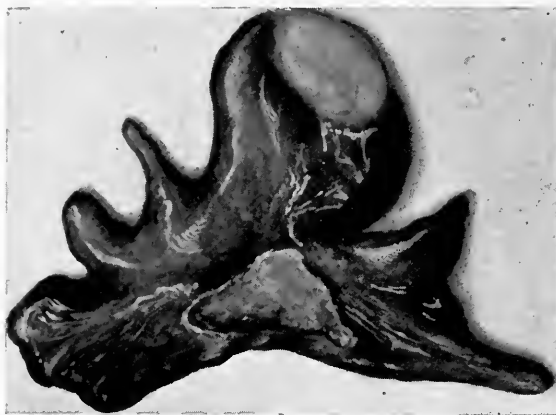


FIG. 175. This shows the actual size of a fibro-lipomatous growth removed from patient described in the text. The base of the pedicle is indicated by the triangular area at the bottom of the central portion of the cut, the remainder of the tumor being freely moveable and capable of interfering with the motion of the joint by imposing itself between articular surfaces.

inner side of the joint. It consists partly of fibrous and partly of fatty tissue.

The functional result after operation has been entirely satisfactory and symptoms have wholly disappeared.

There is usually a sense of tenseness within the joint and this gives way

to pain usually referred to the region beneath the patella. The pain is not very severe as a rule but is sufficient to cause considerable inconvenience. There may be a temporary "locking" or "catch" within the joint when the overgrowth has attained sufficient size or the joint is sufficiently relaxed to permit of the hypertrophied tissue dropping down into the articulation and becoming pinched. Crepitation is present sooner or later in the majority of these static joints and may be fine or coarse, seemingly dependent upon the size of the affected synovial folds and the condition of their surface and not at all upon lack of a proper amount of joint fluid. Climbing the stairs or going up and down hill causes the greatest amount of disturbance in the function of these articulations. Prolonged standing was found to be the only thing that disturbed one patient,



suffering from this condition. He could walk indefinitely. Very rarely do the joints give out, causing him actually to fall, a symptom not infrequently seen in displacements of the semilunar cartilage. When this occurs it is because of the acute pain which results from pinching the fringe, and the involuntary attempt to escape from the discomfort. Fixation of the joint in a flexed position does not occur in this condition as it may in dislocation of the semilunar.

Objectively there is not a great deal to observe upon physical examination. Sometimes the patients are flabby muscularly and seem generally relaxed and out of condition. There is some fullness on either side of the patellar tendon below the inferior border of that bone, and occasionally the fossæ on either side of the patella are more or less obliterated. (Figure 176.) There is rarely any

swelling of that portion of the knee joint above the patella either to inspection or to palpation. Fluid is not present in excess, except as it may happen that the examination be made shortly after an occasion when the fringe has been pinched and a traumatic synovitis been induced. On palpation the enlarged alar ligaments can be easily felt. By pressing on either side the lipoma of the



FIG. 176. A case of diffuse lipoma of the knee joint. The wrinkling in the skin was caused by the application of adhesive plaster strapping. Note the filling up of the fossæ on either side of the patella, and particularly opposite the end of the arrow, this being the usual seat of the greatest lipomatous change in the knee joint.

opposite side can be made to move, together with the patella over it.

There is rarely much tenderness to pressure over these enlargements. The surface temperature is not increased. Except in cases where the hypertrophy is very great no interference in the motion of the joint is experienced, and when this is the case it is usually complete extension that is interfered with; flexion remains normal. When there is interference with extension attempts to secure this motion are accompanied by pain; otherwise motion is not painful. Crepitation, as has been said, is commonly present and can sometimes be heard as well as felt. Static defects in the feet and knock knee will be found in a good many instances if carefully sought.

The symptoms of the diffuse lipomata differ in only a few minor particulars from those seen in the fibro-lipoma of the alar ligaments. These tumors occur usually in persons who are possessed of more than an ordinary amount of subcutaneous adipose.

**Case IV.** Female. Age, 50 years. Entered Hospital Clinic March 4, 1907.

Two months ago patient slipped on the ice, falling heavily on her two knees. The left one seems to have sustained no permanent injury while the right is gradually becoming increasingly uncomfortable. The pain is referred to the patella and more especially to its inner side. On two or three occasions she has felt something slip in the joint and has seemed to lose all power of extension of the leg for a short interval. Sometimes this has been accompanied by considerable pain.

On examination there is swelling in the upper outer quadrant of the knee joint and on palpation this area is very sensitive to deep pressure. There is a thickening of the synovial membrane in this region which does not seem to be wholly an infiltration of the serous tissues but as though it were partially detached from them and moveable within the limits of a short pedicle.

The subpatella fat may be enlarged along with the enlargement of other portions of the joint. The lateral fossæ are almost always obliterated. There is general thickening of the entire joint capsule and in the majority of instances a distinctly palpable tumor can be felt in the upper outer quadrant. This also extends across to the opposite side in some cases. It can sometimes be clearly defined by palpation; slips beneath the fingers and is usually very tender to pressure, which assists in distinguishing it from the edge of the vastus externus. After the patient has been kept in bed for a day



FIG. 177. A lateral view of a wrist showing the villous thickenings caused by enlargement of synovial membrane. This occurred in the course of an infectious polyarthritis. The wrist joint was opened and the tips of these villi had already undergone fatty degeneration.

the tumor diminishes very notably in size. The subjective feelings are much the same in this condition as were noted above. A disagreeable tenseness within the joint with more or less actual pain, rarely any definite "locking" or "catching," a tendency to become "knee sprung," with occasional throbbing sensations as though the circulation were locally disturbed, are the usual symptoms. This type is very much more prevalent in women than in men and is due to a fatty infiltration. It is also occasionally seen in stout rapidly growing girls at puberty.

The third type represents a degenerative tissue change in villi

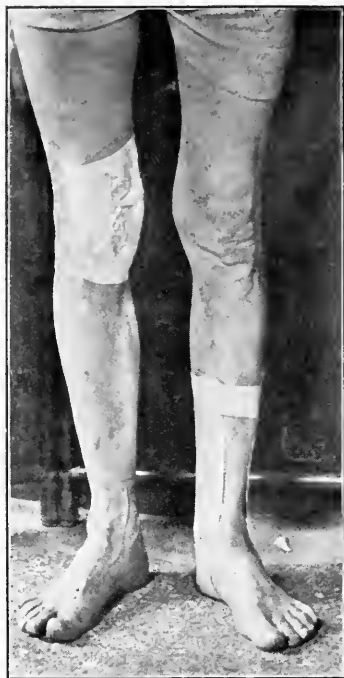


FIG. 178. Illustrates the application of strapping for the treatment of lipoma and villous changes within the knee joint. This is applied in two layers and extends on the inside as far as the edge of the tendons of the inner hamstrings, and on the outer side as far as the tendon of the biceps. In applying it the strips should be made to adhere in the middle line first, and the flesh drawn from above the outer and inner sides of the knee toward the median line before the free ends of the strip are attached. The first row should be put on with the obliquity indicated in the illustration; the second row should be put on circularly. A flannel bandage should be applied over this to be worn a few hours. When properly applied it will last for two weeks. Water must not be brought in contact with it.

which have become hypertrophied through precedent inflammatory conditions. (Figure 177.) Symptoms as well as physical signs are not usually confined to any one or two large joints but are present in many articulations. The symptomatology is therefore that of a general infection, mild or severe, with certain local signs which are incident to the tissue changes within the joint.

Diffuse capsular thickening is obvious to inspection and palpation.

The villous character of this thickening can be determined very readily on palpation, as the thickened villi can be made to roll under the fingers. Motion is more often interfered with and flexion deformity is more likely to occur in this than in the other types. The symptoms, as well as the physical signs, are inseparable from those seen in chronic villous polyarthritis.

**Treatment.**—This varies for the type with which one has to deal. In the first there is less likelihood of a spontaneous cure, less risk in the operative treatment, and greater certainty of success in the pursuit of this plan of treatment than in either of the other types, and yet because this is so, one should not

choose that method at the outset. Conservative measures consist in fixation and (Figure 178) compression,—the former to prevent further irritation of the growth by the ordinary use of the joint, and its consequent hypertrophy, and the latter to induce shrinkage of the growth through the effect of pressure and the absence of irritation.

An association of lipomatosis and the hypertrophic type of chronic non-tuberculous joint disease is not an uncommon occurrence, suggesting that possibly the metabolic disturbances which are concerned in the production of the two processes are not very unlike. The following case illustrates this condition very well.

**Case V.** Mrs. G. H. M. Age, 62 years. Complaint. —Lame knee. Duration. — One year.

Has never had any trouble with her joints before this present attack. Attributed the early symptom, which was pain in the right knee, to varicose veins. Pain was aggravated by use.

In the fall of 1904 she had massage, under which treatment the joint became more stiff and swollen. The winter of 1904-5 she was confined to the house largely on account of the disability in this right knee. There has been no redness or tenderness or increase in the surface temperature.

On physical examination the right knee is found to be 1.5 cm. larger than the left below the patella; 1 cm. smaller than left over patella, and 3 cm. larger than the left above the patella. The circumferences of the calves were the same. It is impossible to completely extend the right knee and attempts to do so are accompanied by much pain. Normal flexion in the knee joint. Over the inner aspect of the right knee, both above and below the line of the joint, is a well-marked swelling. On deep palpation there is marked tenderness over the inner aspect of the knee. No excess of fluid. Both feet are rather flat but symptomless. The patient has a great excess of subcutaneous fat and has had a lipoma removed from her right thigh and now has a quite marked one above the right clavicle, near the shoulder joint. The lipomatous infiltration

of the alar ligaments has persisted and she has never been able to completely extend the knee joint.

An X-ray shows some hypertrophic arthritis of the patella but none of the other bony components of the knee joint. Treatment in this case has been strapping with adhesive plaster, which has given comfort while she has worn it but has produced no other visible or appreciable effect upon the local condition in the joint.

Failing to accomplish anything after four or five strappings at two-week intervals, radical treatment should be considered. Along with this treatment the patient should be enjoined to avoid the stairs and walking, if pain is caused by use. Strapping sometimes aggravates the pain instead of relieving; when it does, it is because the fringe has been retained in such a position as to be pinched by extension of the leg and a fresh strapping should be applied after manipulating the leg to readjust the fringe.

The radical treatment should consist in a lateral incision (Figure 179), preferably over the inner aspect of the joint, as it is from this side that the most room can be obtained and the greatest amount of the hypertrophied fringe can be reached. It is sometimes necessary however to make an incision on both sides of the joint in order to thoroughly explore the cavity. The wound should be closed layer by layer with interrupted catgut or silk sutures with "seton" drainage for twenty-four hours. Either a plaster of Paris splint or a voluminous soft dressing of sterile gauze and bandage should be applied at the time of the operation.

If there has been no deformity (flexion) previous to the operation, plaster is not necessary. If complete extension has not been possible, plaster had best be applied. Stitches should be removed at the end of the first week and gentle passive manipulation commenced at once. It is usually possible to secure right-angle flexion during the second week, and when this has been secured and two weeks have expired, the patient may be allowed to walk on the leg with the assistance of a cane. Three to four weeks should put the joint in a practically normal condition.

The treatment of the second class of lipomata is less frequently operative. Strapping will often compress the fatty deposits in the joint so as to remove them from harm's way and permit normal function in the articulation. At times however it is necessary to perform an arthrotomy. There is much more risk connected with operation upon this type than there is upon the fibro-lipoma which has just been discussed, as fat tissue is more capable of being bruised and its resistance lowered in this way, so that the joint is deprived of some of its native resisting power to infection. The same incisions may be utilized for exploration of the joint as in the former type, though usually the larger growth is in the upper outer quadrant of the joint, and naturally the outer incision will be made and will be carried higher up toward the top of the quadriceps pouch than the incision for the alar ligament fringe. Extraordinary aseptic precautions should be observed in this condition. A very considerable part of the synovial membrane may be dissected out; in fact, one need not hesitate to dissect as freely as he chooses, because it will be impossible to remove it all, and if small islands are left, as they invariably will be, they are capable of regenerating the entire membrane. Failure to secure motion after arthrotomies in which extensive denudation of the synovial membrane has been practised is not so much due to the loss of the membrane as to the failure to keep denuded surfaces apart long enough to allow the synovia to cover them over. In arthrotomies performed for this purpose



FIG. 179. Note the situation of the incision over the inner aspect of the joint, which gives easier access to the fringes and lipomata within the joint than does the ordinary incision for removal of the semilunar cartilage, the latter incision being parallel to this, but further from the inner border of the patella.

the same after-treatment is necessary as has been above indicated except that even more emphasis should be laid upon early manipulation in order to avoid subsequent stiffness. In this type of lipoma dietetics are of value in some cases. It is generally possible to remove fifteen to twenty pounds of flesh without uncomfortable stringency in the diet and this is sometimes attended by local improvement.

In the third type of lipoma the indications for surgical treatment are those which have been outlined in the discussion of infectious arthritis and chronic villous arthritis. In this latter type of lipomata the risk of surgical interference is the greatest of all, because a degenerated tissue is even more susceptible to infection when in addition to its naturally low resisting power it has been severely bruised, as is sometimes the case in the diffuse lipomata. Much more experience is necessary in determining the proper time and the right sort of case upon which to perform an arthrotomy when the cause for the lipomatous degeneration has been a precedent inflammatory process. In other words, such cases are not operated upon because they are lipomatous, but are subjected to surgical interference in order to meet conditions which are detrimental to the articulations in view of the previous infection or because of the mechanical disturbances produced by the presence of hypertrophied villi.



## CHAPTER V

### NEOPLASMS AND THEIR RELATIONS TO JOINT SURGERY

THE introduction of a chapter on bone tumors in a book of this character seems appropriate in view of the fact that many new growths originate so near the joints that the symptoms caused by their presence suggest at once some form of joint disease. The same growth developing away from the joints in the shafts of the long bones would cause but little difficulty in diagnosis.

At this time much attention is being paid to chronic joint disease in the adult, and it is doubtless for this reason that orthopædic surgeons are seeing many more new growths than formerly. Malignant bone tumors are more common than benign ones, and for this reason their early recognition is of great importance. Epithelial growths are more rare than those derived from connective tissue because epithelial cells are not found in bone, neither are there glandular cells present in such tissue, in which carcinomatous changes may take place. In consequence of this fact primary carcinoma of bone is of extreme rarity. On the other hand, metastatic osseous carcinoma and epithelioma are not very uncommon.

**Endotheliomata** <sup>1</sup> developing from the lining membrane of blood vessels which supply nourishment to bone is a very rare form of new growth. The writers have seen one angioma (Case 1) within the knee joint, but this is the only neoplasm of this description of which we have personal knowledge

**Sarcomata** may be either primary in bone or metastatic. Of the primary tumors, central or giant-celled sarcomata and periosteal sarcomata are the most common. True myelogenous sarcomata are very densely packed with giant cells <sup>2</sup> and these are of very large

<sup>1</sup> Brandt, *N. Y. Med. Jour.*, Nov. 17, 1900.

<sup>2</sup> Trotter, *Clin Jour.*, London, 1906-07, xxix, 198-208.

size; they differ in this respect from sarcomata in general, which have but few giant cells. This fact must be recognized in making diagnoses, because it is of great importance in treatment and prognosis. True myelogenous or giant-celled sarcomata are capable of being removed without necessarily sacrificing the limb, whereas round or spindle-celled sarcomata, that may contain a few giant cells, are very malignant and are liable to local recurrence as well as metastases. Closely related to the sarcomata are the myelomata (Case II), and twice in the writers' experience have symptoms due to new growths of this character been regarded as indicative of non-malignant constitutional disease in the nature of an arthritis. In neither case did albumose appear in the urine, though carefully sought.

**Chondromata** (Case IV) are not malignant in the sense that many of the sarcomata and carcinomata are. They do not form metastases, but they recur locally unless very thoroughly removed, and in the process of growth give rise to very serious disabilities largely through pressure. They do not infiltrate tissues outside the structure in which they are primary, but push them aside as they increase their dimensions.

**Osteomata** (Cases V and VI) situated close to the epiphyseal line, yet developing from the diaphysis, are quite frequent, particularly at the lower end of the femur. Cysts (Case VII) in the long bones are oftentimes confusing. They are due to various causes: some are doubtless congenital, others are the result of inflammatory disease<sup>1</sup> attacking bone secondarily, e. g. typhoid fever; and others still are trophic, as in the case of osteomalacia.

**Lipomata** (Case VII) occur in the larger joints, particularly the knee, with comparative frequency. The "lipoma solitarium" of Koenig is the only one needing consideration here. They generally appear as part of a diffuse lipomatosis, but the writers report one case here in which a joint lipoma was associated with two subcutaneous lipomatous growths, one on the side of the neck and one on the shoulder. Interesting to the orthopædic surgeon as is the

<sup>1</sup> Unger, *Deutsche Med. Woch.*, August, 1901.

whole subject of bone tumors and cysts, it is of paramount concern to him only as they are juxta- or intra-articular.

Tumors in the shafts of long bones he is not particularly interested in. In flat bones, e. g., the innominate and scapula, he is occasionally called upon for a diagnosis. Where however kyphosis of the vertebral column is produced by new growths he is oftentimes consulted. Juxta-articular neoplasms are very likely to give rise to joint symptoms and for this reason are of particular concern.

## DIAGNOSIS

Whenever the suspicion of a new growth arises there are certain broad general considerations, the observance of which will often lead to a correct diagnosis, — cachexia, anæmia, progressive loss of strength, previous history of tumor for which surgical aid has been invoked, gastric and intestinal disturbances, rapid and progressive loss of weight, — all these subjective symptoms and facts from the history of the case are significant if occurring in any considerable number, provided they can be correlated to a group of objective physical signs not inconsistent with those produced by a neoplasm. It not infrequently happens that women who have been operated upon for mammary or other cancer and who subsequently develop metastases in the spine or elsewhere in the osseous skeleton will not attach any significance to their original trouble and will even avoid including such a matter in a summary of their previous illnesses. If there has been no local recurrence and a year or two has elapsed since operation patients frequently put out of mind that which has had so much of horror connected with it. In view of this very natural tendency it is of particular importance to make special inquiry into the history of previous malignancy.

**Sarcomata.** The malignant connective tissue tumors, of which sarcoma is the chief representative, are as a rule of commonest occurrence during the adolescent and earlier years of adult life. They are not unusual in childhood and are quite rare after the mid-period of life. The age of a patient who has symptoms in or about a joint

may, therefore, be of significance. Pain of a persistent, gnawing, aching character, not infrequently characterized by remittences, generally referred to the locality in which the tumor is situated and not to some point remote from it, is quite characteristic of sarcoma. Pain in sarcomatous growths is not aggravated by use of the limb or joint in which it is located and is rarely of that sharp, shooting, "knife-like" character which those who suffer from inflammatory bone or joint troubles describe. Neither change in position, fixation, nor traction affords any permanent relief to the discomfort of a patient possessed of a bone sarcoma, — at least, none which is comparable to that experienced when these measures are applied in inflammatory diseases. As a rule the pain of the central, myelogenous sarcomata is less than in the periosteal variety. There is more room in the medullary cavity of the bone for expansion of the tumor and its slower growth more gradually expands the cortical covering. Stretching and infiltration of the periosteum is a painful process. There is occasionally a marked let-up in the severity of pain in the periosteal tumors, marking the time when the growth escapes from the confinement of its periosteal covering and commences to infiltrate softer structures. It is in this type also that spontaneous fractures are most likely to occur.

**Muscular spasm.** In non-inflammatory processes there is not the spasmodic effort to protect the joint which there is in processes caused by bacterial invasion. Even when a new growth breaks through into the cavity of a joint, or even when primary there, any restriction in motion which that joint may suffer from is due largely to the mechanical effects of the tumor's presence and not to muscular spasm.

**Swelling and consistency of tumors.** Osseous sarcomata of the myelogenous type, when juxta-articular, cause a very symmetrical distention of that portion of the bone nearest the joint. If the bone affected is the lower end of the femur one condyle may show greater swelling than the other, but it still will be symmetrical and smooth. There may be some enlargement of the joint and possibly a little synovitis, but infiltration of the synovial capsule is usually absent.

Tenderness to pressure over the tumor, though slight and brought out only by rather deep firm compression, is quite constant. In some cases it is claimed that the cortical bone can be crushed in by compression, accompanied by a crackling sound. The writers have been able to demonstrate this once through an exploratory incision of the knee joint, on which occasion it was possible to push the finger through the cartilage covering the femoral condyle into the substance of the tumor. In periosteal sarcomata there is great irregularity of contour, less symmetry in the development of the tumors, and a much denser consistency, and more nodular feel to the surface of the growth than in the myelogenous tumor.

**Atrophy.** Muscular atrophy, which is such a conspicuous feature of all inflammatory affections of the joints, is very much less conspicuous in sarcoma of bone and joint. What little there may be is of slow development and the result of the disuse of muscles. Over the region where a new growth is located the tape measure will very early reveal an increase in size as compared with a corresponding portion of the other extremity. Distention and tortuosity of the superficial veins is occasionally noted over osseous new growths. Blanching of the skin and infiltration by the tumor is sometimes noticeable in long bone sarcomata, and slight increase in surface temperature, particularly in rapidly growing tumors, is the rule. Blood examination is not of any particular value for diagnosis. There may be a slight increase in the number of white corpuscles and a slight diminution in the number of red cells in actively growing neoplasms. Schiep<sup>1</sup> claims to have found cells in the blood streams of patients suffering from malignant tumor of bone, carcinoma as well as sarcoma, differing from the cells characteristic of leukæmia and severe anæmia. These cells were present in one case of osseous sarcoma to the extent of 9% and in another of 14%, of the total number of leucocytes found in the blood. He also refers to percussion of the shafts of long bones as a means of detecting, through their tenderness, the presence of sarcomatous bone marrow. Breaking down of sarcomatous tumors is rare, so that

<sup>1</sup> Schiep, *Zeitschr. f. klin. Medizin*, l, lx, nos. 2-4.

skin infiltration and ulceration over the growth is not commonly seen.

Spasticity, exaggerated reflexes, sphincteric paralysis, and even complete paraplegia, may be the earliest sign of which cognizance is taken, pointing to a sarcomatous involvement of the vertebræ. A traumatic history is very frequently associated with the development of sarcomata.

[ **X-ray examination.** Too great reliance should not be placed in the X-ray when employed as an aid in diagnosis. Though the radiograph is suggestive, there are no absolutely pathognomonic signs of sarcoma in a skiagram. Osteomyelitis simulates in appearance the osseous changes seen in periosteal sarcoma (Figure 180). It is from this there is the greatest difficulty in differentiation. Spiculation combined with rarefaction gives the most suggestive skiagraphic representation of sarcomatous change, but spiculation is constantly occurring in the osteomyelitic X-ray. Multiple tumor formations in bone, associated very frequently, though not always, with the presence of albumose<sup>1</sup> in the urine, generally indicate that form of sarcoma known as myeloma. This is a very chronic bone tumor which has periods of exacerbation and remission uninfluenced by treatment. The general tendency of these growths is progressively bad, and their termination is always fatal. Two instances of this tumor are related among the cases cited.

**Carcinoma.** Medullary carcinoma is the most common form seen in the osseous skeleton and is generally secondary to cancer of the breast in women and to intestinal carcinoma in men. Epithelioma (Case xi) develops in old sinuses quite often and from there invades the bone. An instance of this appears among the cases cited. The benign tumors, e. g., osteoma and chondroma, sometimes take on malignant characteristics late in life. Most of the symptoms to which they give rise are caused by compression of vessels or nerves through the mechanical pressure of the growth. They are frequently mixed tumors, certain histological features of a chondroma, an osteoma, and a sarcoma combining in one new

<sup>1</sup> Devic et Beriel, *Revue de Chirurgie*, Paris, xxvi, no. 10.

growth partaking of the clinical characteristics of its component tumors.



FIG. 180. This shows the close resemblance of certain of the malignant sarcomata to chronic diffuse osteomyelitis. This was thought to be a sarcoma but proved to be osteomyelitis.

The literature is very rich in reports of tumors of the osseous skeleton.<sup>1</sup> Schalemouse discusses "the joint participation of osteo-

<sup>1</sup> *Journal of American Medical Association*, July 11, 1900 (abstract).

sarcomata of long bones." In thirty cases of sarcoma of long bones 50% of them presented symptoms of an inflammatory arthritis. The knee was the joint concerned in six of these. He found the greatest difficulty in distinguishing between tuberculosis, syphilis, and tabetic or Charcot's joints. He believes that previous history of malignancy, age, sex, constitutional conditions, or trauma have no significance. On physical examination he finds that pain is not characteristic of these tumors. He lays most stress upon the consistency of the tumor and its irregularity. He finds that sarcoma about the knee joint tends to infiltrate the popliteal space, and points out the fact that motion is preserved to a considerable degree in sarcomatous involvement of joints, and that rest, immobilization, and other measures which commonly give relief to inflammatory processes in joints have no beneficial effect upon sarcomatous articulations.

Marsh <sup>1</sup> cites four cases where diagnosis of malignant bone tumor had to give way to that of inflammatory bone disease, and calls attention to what he regards as the points in such a differential of the greatest significance. Under twenty years of age the proportion of inflammatory to malignant diseases in bone is as one to three. Rate of growth, shape and consistency of tumor, condition of the skin and deeper soft parts over the tumor, pain, and temperature are the points toward which he directs attention most closely. Even then he says that many times it will be necessary to invoke the aid of incision, followed by a gross and possibly an histological examination before a positive diagnosis can be reached.

Longemot <sup>2</sup> reports a case of chondroma and calls attention to the difficulties in differentiation from tuberculosis, a difficulty the writer has experienced in one instance (Case III) and was able to make the diagnosis only after operation. The points which he regards as of most importance to observe in this case are in relation to atrophy, deformity, exudate, pain, and capsular thickening.

Osgood <sup>3</sup> has reported a case of osteosarcoma of the humerus,

<sup>1</sup> *St. Bartholomew's Hospital Reports*, 1892, vol. xxviii, p. 7.

<sup>2</sup> *Archiv f. Orth., Mechanother., u. Unfallchir.*, Bd. ii, Heft 2, S. 213.

<sup>3</sup> *Boston Medical & Surgical Journal*, April 24, 1902.



situated close to the elbow joint, where the diagnosis lay between osteomyelitis, rheumatoid arthritis, and tuberculosis. In this case the X-ray was called upon to clear up the diagnosis, but showed a radiograph not inconsistent with osteomyelitis or tuberculosis, and it was so diagnosed until it became necessary to interfere surgically, when the real nature of the process was determined.

Judson <sup>1</sup> reports three cases of malignant spinal disease, one a sarcoma in a boy of four and one-half years, and two cases of carcinoma in males of thirty-five and forty years respectively. These all resembled Pott's Disease very closely.

Pierce and Buckley <sup>2</sup> report a case which was brought to the hospital in an ambulance, suffering from paraplegia and paralysis of both sphincters. They call attention to the significance of early and persistent girdle pains in this case as being significant of the nerve-root pressure occurring in malignant spinal disease.

Coley's <sup>3</sup> recent article on "Sarcoma of the Long Bones," published in the *Annals of Surgery* for March, 1907, and Colvin's paper on "Sarcoma of Bone" <sup>4</sup> give valuable suggestions as to the diagnosis of these growths, together with carefully studied groups of cases. Coley calls attention in the differential diagnosis particularly to bone cysts, tuberculosis, syphilis, and osteoarthritis.

The following list of cases tends to show the variety of neoplasms which may be met in the experience of a chronic joint clinic. In some cases it would be very easy to add other instances of particular tumors, but repetition in a non-statistical report would be of no particular value. Enough has been said to draw attention to the necessity for care in the examination of any case of swelling of the long bones, whether located in the shaft or juxta-epiphyseal.

The following cases are reported in considerable detail because all of them presented some difficulties in diagnosis, and in many cases diagnosis could not be made, or at least was not correctly made until operation permitted an histological examination.

<sup>1</sup> *Medical Record*, October 31, 1891.

<sup>2</sup> *Journal of American Medical Association*, January 30, 1904.

<sup>3</sup> *Annals of Surgery*, Phil., March, 1907, p. 321-368.

<sup>4</sup> *St. Paul Medical Journal*, April, 1906.

**Case I.** — Miss T. M. Age, 22 years. Diagnosis. — Angioma of knee.

November 29, 1903. — At twelve years of age had an acute trouble in the right knee characterized by swelling, pain, and loss of motion. All these symptoms disappeared except a swelling on the outer side of the knee. When too much used this would become sore and trouble her a good deal. Five days ago it started up again and has been very painful, especially at night.

Physical examination. — Thin, poorly developed woman. Right knee shows marked swelling over outer side just above the patella. There is no heat or redness, but exquisite tenderness and a seeming fluctuation. Right knee is one-half inch larger than the left. Right calf is one-half inch smaller than left. The thighs are the same size. Cannot completely extend leg on account of pain. Flexion is also restricted by spasm. Five days ago motions were normal.

Operation advised.

December, 1903. — Operation. An incision over the outer side of the knee directly through the swollen area showed a normal appearing fibrous capsule, after incising which the synovial portion of the capsule seemed to be composed of small blood vessels, very irregularly arranged, in much the condition one finds in varices. The surface occupied by this varix was approximately  $2 \times 2\frac{1}{2}$  inches, and in this region the synovial capsule was several times thicker than it should be. This was excised in its entirety, and nothing else was found abnormal within the joint.

June, 1906. — The knee is causing her practically no trouble and on inspection and palpation seems practically normal.

**Case II.** — Mr. M. C. Age, 48 years. Diagnosis. — Myeloma.

Entered the Clinic early in 1904. He was complaining of a great deal of pain along the outer side of his left arm extending to the fingers. This had been so severe for the previous six weeks that he had been obliged to take morphia subcutaneously in large doses. At the time he came to the hospital he was taking a half grain three times a day, which was only sufficient to benumb his

sensations. The arm was atrophied; there was considerable diminution in the power of the left hand; there was no restriction in the motions of the shoulder, elbow, or wrist; the cervical spine was stiff in side-bending in both directions. There was no evidence of arthritic lesions in any other part of his body. He had lost considerable weight, was sleeping very little at night, and had no appetite. The question of diagnosis seemed to lie between a pachymeningitis and a cervical osteoarthritis.

At a subsequent examination it was discovered that on the surface of his scalp were two or three small, tender, immoveable, semi-solid nodules, which had been there for some time and which he stated varied in size from day to day. One of these was removed and on histological examination it was found to be a myeloma. In view of this, a neurological opinion was obtained, and upon the suggestion of the Neurological Department operation upon the cervical spine was advised. A laminectomy was performed exposing a myeloma involving the transverse processes of the fourth, fifth, and sixth cervical spines on the left side. This was as thoroughly removed as possible and the patient was in consequence very much more comfortable.

Subsequently, however, there was a recurrence in the right scapula, for which a second operation was performed, and still later there was a recurrence in the lumbar spine, causing symptoms in the right leg similar to those which he had had in the left arm. The patient's condition was so poor that no further operative interference was considered and he subsequently died, less than a year after the first operation.

**Case III.** — Miss F. P. Diagnosis. — Chondroma of tibia.

October 22, 1903. Age, 23 years.

Family history. — Negative as to chronic disease or joint trouble. No phthisis.

Personal history. — Always well until January, 1903, when the right knee began to be stiff and she walked lame. Slight swelling. Pain was severe, especially at night. Knee was drawn up and could

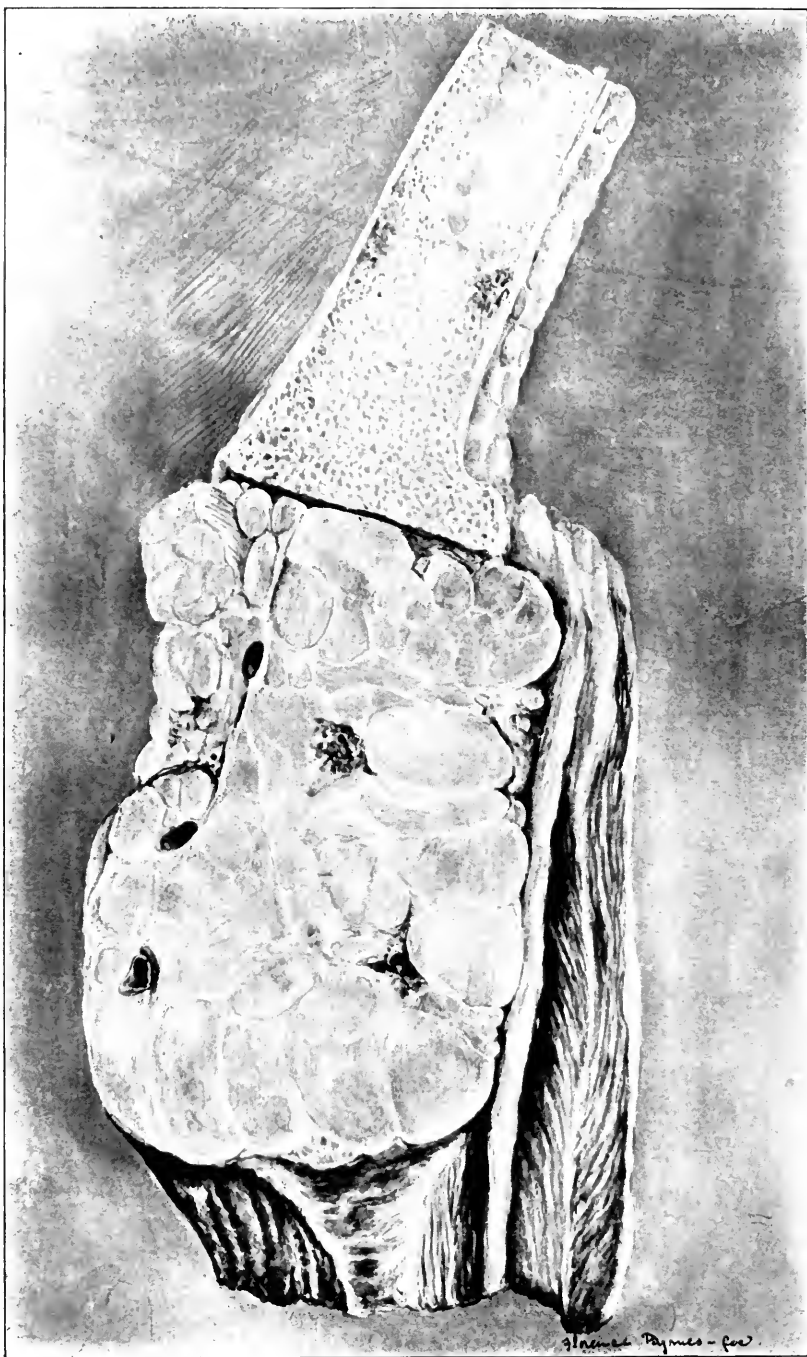


FIG. 181. Observe growth of tumor which had enlarged the upper end of the tibia.

not be extended. No injury. No sickness of any sort previous to the present trouble. Onset slow. General health fairly good. Appetite poor and has lost a good deal of flesh. In May, 1903, an incision was made over the knee but no benefit resulted. No more deformity now than when operated.

Physical examination. — Considerable swelling over the outer tibial condyle. Leg can be extended to within  $20^{\circ}$  of completed extension. Motion in flexion to within  $20^{\circ}$  of the extreme. Patella freely moveable. Sinus over the inner tibial condyle healed. Meas-

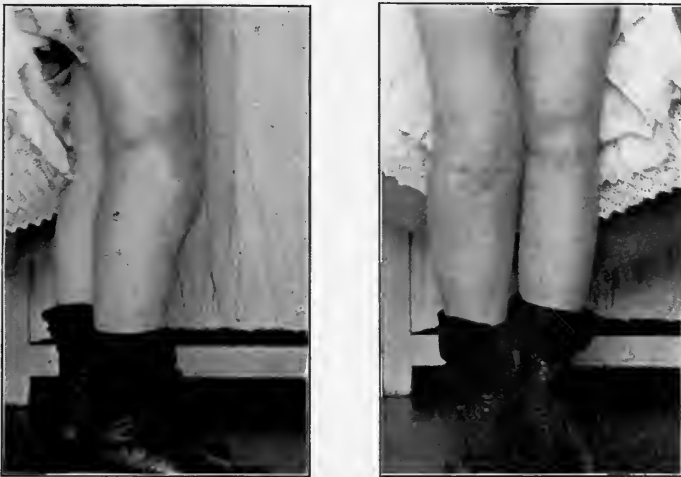


FIG. 182. Front and side view of patient whose tumor was shown in Figure 181.

urements over right patella, 36 cm.; over left, 34 cm.; below right patella, 34.5 cm.; left, 31.5. Atrophy of calf, 1 cm. Thigh, 1 cm.

Operated early in November, 1903, and on cutting through the sinus on the inner surface of the tibia a soft material was found exuding from the sinus and continuous from the opening of the sinus up the shaft of the tibia to the inferior surface of the cartilage covering the tibia. This material was curetted out, the edges of the sinus excised, and the material sent to the pathologist for examination. Pathological report, chondroma.

Secondary operation performed seven weeks later, and knee joint opened as if for an excision. On removing the cartilage from the

head of the tibia this same cartilaginous overgrowth was seen involving the entire condyle of the tibia, and as far as could be reached down the shaft of the bone with an average-sized curette this same material could be brought to the surface. Patient was not prepared for amputation and the wound was closed after making as thorough a curettement as possible. Convalescence was uneventful, but the tumor soon returned and pain became so severe that patient permitted an amputation of the thigh.

**Case IV.** — C. H. Diagnosis. — Osteoma of the femur.

January 6, 1904. Age, 13 years. Complaint, disability in right leg. Duration, 3-4 days. Cause, unknown.

Physical examination. — Just above condyles of femur on inner and anterior aspect is a hard mass as large as a pullet's egg, evidently attached to the bone.

April 1, 1904. — The exostosis on right femur has increased in size but has caused no symptoms of any sort.

April 2, 1904. — Operation. Incision 6 cm. long over the growth on the inner and anterior aspect of the right thigh. Muscle fibres of the vastus internus separated and a tumor the size of a large English walnut exposed. The pedicle was at the lower border of the growth and was about 1.5 cm. in diameter. The upper end of the tumor was quite lobulated, yellowish-white in color, and of the consistency of cartilage. The lower part was bony in character and was firmly attached to the shaft of the femur. With a chisel the growth was excised and that portion of the femur at the base of the growth for a depth of one-eighth inch was also removed.

May 17, 1904. — Function of leg normal. No swelling except slight post-operative thickening in the soft parts. No tenderness.

May, 1907. — No recurrence of tumor.

**Case V.** — Mrs. F. E. B. Diagnosis. — Osteoma of femur.

July 20, 1906. Age, 33 years. Complaint, left knee. Duration, several years. Cause, not ascertained.

Twisted knee in spring of 1906. Some swelling at that time. A

tumor appeared on outer side above the knee which seemed to the patient to slide up and down. Pain now after use, and the leg becomes very stiff after any considerable rest.

Physical examination. — Well-developed and nourished woman. Over the outer side of the left thigh just above the knee joint is felt a marked slipping and crepitation on every attempt to flex or extend the leg and at this point can be felt an immoveable bony prominence connected with the femur projecting outwards to within one-half inch of the surface of the skin, and when this is firmly grasped the vastus externus can be felt to slip over it at every motion.

X-ray shows a very marked bony spur projecting from the side of the femur.

This was removed at operation and proved to be an osteoma similar to that reported in Case iv.

**Case VI.** — Mr. S. Age, 26 years. Diagnosis. — Bone cyst (typhoid fever).

Entered the Hospital in December, 1906.

Two years previously was very ill with typhoid fever. No other sickness of any consequence. Denies venereal diseases. Since his convalescence from typhoid has complained more or less constantly of pain in the right tibia. This has extended pretty much the entire length of the bone, has never been very acute, but has constantly made its presence felt. On palpation over the surface of the bone there is some soreness, but independent of this, motion and weight-bearing do not aggravate his symptoms. There is no atrophy of the muscles and no enlargement of the bone. An X-ray showed multiple cysts of the tibia and operation was advised. (Figure 183.)

This was performed in January, 1907, and three small cavities were discovered at the points where the X-ray indicated their existence, and were thoroughly excavated. The cortical bone in which they were situated was much thickened and was more friable than cortical bone in this region usually is. In the centres of these cavities there was a small amount of what appeared to be granulation tissue.

Convalescence has been uneventful and the symptoms have been entirely relieved by the operation.

**Case VII.** — Mrs. G. H. M. Diagnosis. — Lipoma, knee.

March 24, 1905. Age, 62 years. Complaint, lame knee, right. Duration, one year.

Up to the onset of the present trouble patient has never had any joint disease. Her general health has always been excellent. At first it was thought pain in right knee was due to varicose veins. The pain was made worse by moving. During the fall of 1900 she had massage for three months, during which time the knee became stiff and swollen. During this past winter has been confined to the house. For past three weeks has not had massage. Does not miss it and thinks knee is just as well without it. No sensation of "catching." No redness or heat. Knee is comfortable when at rest.

Measurements.	Right.	Left.
Over patella,	44.5 cm.	45.5 cm.
Below patella,	40.5 "	39. "
Above patella,	51. "	48. "
Calf,	40. "	40. "

Cannot with any comfort allow the knee to be extended. Marked swelling exists as above indicated, but it shows mostly over the inner aspect of the right knee both above and below the line of the joint. Cannot extend the leg beyond 70° from right-angled flexion. No superficial heat or tenderness. Deep tenderness on palpation over inner portion of knee. No excess of fluid.

Both feet are rather flat, but symptomless. Flexion is free in the knee. Is a stout, well-nourished woman and always has been. Had a lipoma removed from right thigh several years ago. There is now a small one palpable above the right clavicle near its humeral end.

**Case VIII.** — Miss E. J. Age, 20 years. Diagnosis. — Giant-celled sarcoma.

In March, 1906, the patient entered the Clinic, complaining of pain in the right knee which had lasted for four months. Previous to that time she had had some slight inconvenience for several



months but had thought nothing of it. For the four months previous to her entrance however there had been a considerable amount of pain, causing loss of sleep and the leg had tended to



FIG. 183. Observe on the inner side of the tibia two light areas which contained at operation a little clear fluid and a small amount of granulation tissue. The fluid was sterile on culture.

flex somewhat. Walking was accompanied by a limp and some pain was occasioned by stepping on the foot. She had lost weight, was quite anæmic, and in rather poor condition. The right knee was symmetrically swollen from the femoral condyles up the shaft of the femur about three inches. The capsule of the joint was not much thickened; the bone was rather tender to deep pressure; the knee was flexed about  $15^{\circ}$  and could not be extended, but further flexion was possible beyond an arc of  $45^{\circ}$ , though discomfort was caused by this motion. An X-ray was taken which showed rarefaction of the lower three inches of the femur and symmetrical enlargement of the cortex. There was some increase in the surface temperature of the joint, but no increase in the bodily temperature. There was no history of injury or previous bone disease in the family. Glands in groin were not enlarged.

Exploratory operation advised. On making pressure upon the shaft of the bone close to the trochlear surface a crackling sensation was produced, and it was easy to penetrate the cortical bone with the finger. The shaft of the femur was trephined and from the gross appearances a malignant process was diagnosed.

At a subsequent operation the thigh was amputated at its mid point. Patient made an uneventful convalescence. There has been no indication of recurrence in any other part of the body nor in the stump. The patient has been fitted with an artificial limb upon which she is walking.

The pathological diagnosis was giant-celled sarcoma.

**Case IX.** — Miss F. B. Diagnosis. — Sarcoma of the knee.

February 3, 1906. Complaint, pain in left knee. Duration, eight months.

The patient fell down stairs about a year ago and injured the left knee, but had very little trouble in it until about the last of May, 1905, when she sprained it badly and was in a cast for three weeks. She was "laid up" for three months. Ever since has been a little lame. Cannot fully extend the leg. Moderate pain occasionally. Does not have pain at night more than during the day. At

present no locking, but at one time she fell on several occasions because of this. General health is not affected. Has gained some in weight of late and is now overweight. Has had night sweats. No consumption in family.

Physical examination. — Well developed and nourished; rather anæmic. Left knee swollen over the entire capsule both above and below the patella. Over the patella the left knee is three-fourths of an inch and above the patella one-half inch larger than on the right. No muscular spasm. Leg cannot be extended completely. No redness, heat, or tenderness. Knock knee.

Exploratory operation advised.

February 6, 1906. — Operation. Incision three inches long over the inner aspect of the knee joint. Capsule opened and joint explored. Except for apparent increase in size of inner femoral condyle nothing pathological was found. The cartilages were intact and the condyle itself seemed to represent the barrier to complete extension and correction of the knock knee. On incising the condyle a tumor mass was found there, which was removed from the interior of the condyle. Its boundaries were quite easily determined. Histological examination showed a giant-celled sarcoma.

October 6, 1906. — No symptoms either subjective or objective suggesting recurrence of the trouble. Knee can be almost fully straightened and is practically normal in contour.

May, 1907. — No recurrence of tumor.

**Case XX.** — Dr. X. Diagnosis. — Carcinoma of spine. October, 1900. Age, 56 years.

Patient had been suffering for six or eight months with discomfort when driving about the country attending to his practice. For six or eight weeks before he gave up his work he had been obliged to take whiskey and morphia in order to keep himself up to his tasks. Pain was referred to the lower back and thighs. Jarring or jolting seemed to aggravate his symptoms very much. It was impossible to sleep without narcotics and even with their aid he had but very little rest. There was a progressive loss of weight and he was

very anæmic. He kept at his work until it was absolutely impossible for him to continue longer.

On physical examination the man was anæmic, emaciated, and evidently suffering severely. Was very much upset nervously and had no control of himself. Would cry for the greater part of the day sometimes, even when he said pain was not the occasion for it. Spinal motions were somewhat restricted in the lumbar region, both laterally and antero-posteriorly, and fixation in a jacket gave him some relief for a time. There was no antero-posterior deformity of the spinal column. On examination of the abdomen a mass could be felt in the right hypochondrium, suggesting a neoplasm.

The patient returned home having about as much pain as he had been experiencing before, but able to move about and to stand the jolt of the carriage with less suffering. He died about three months after his return and autopsy revealed a primary carcinoma of the cecum with secondary spinal metastasis.

**Case XI.**—G. E. C. Age, 58 years. Diagnosis.—Epithelioma, tibia.

March 28, 1902.—Had a running sore in left ankle for thirty-five years. It then healed for two years and there was no pain. Five years ago he was thrown from a team and is said to have chipped off some bone from this tibia, in which there was subsequent necrosis. The sinus has been open ever since, but he has been able to do hard work on it. Has not been lame.

Nearly one year ago had an operation performed in an attempt to make the wound heal and remove dead bone. The wound has however never healed since, and though there has been no soreness or pus at any time, for two to three months past there has been more swelling and great tenderness. Now uses crutches.

Physical examination.—Large, red, epitheliomatous-looking, granulating area on the inner side of the leg about four inches above internal malleolus. This is about three inches in circumference. Ankle is much swollen. Considerable mobility at seat of lesion suggesting a solution of continuity. No glands felt in groin or popliteal space.



FIG. 184. Note that the tibia has been almost wholly replaced by the tumor in the lower one-third of the leg. Case XI.

X-ray suggests malignant disease. (Vide Figure 184.)

Amputation was performed a few weeks later, during the convalescence from which the patient died of a pulmonary embolus. No autopsy.

Pathological report showed an epithelioma.

**Case XII.** — G. H. R. Diagnosis. — Sarcoma of the ilium. December 23, 1902. Age, 31 years.

Family history. — Negative.

Personal history. — Always well. When running for a car a few months before consulting his family physician, he felt a sharp pain in the right hip. This did not lay him up at the time. Three weeks later he caught a severe cold and then the trouble recurred, and he was laid up four weeks. Always had a limp since, and in September, 1905, after wrenching himself in swimming, he was laid up three weeks. Six weeks ago he had still another wrench.

Physical Examination. — Well developed and nourished. Marked limp in right leg, suggesting hip-joint lesion. Lengths equal; three-fourths atrophy right thigh; three-fourths of calf, and marked atrophy of the buttock. Motions in flexion normally free with but little restriction in other motions. Extreme abduction and extreme rotation slightly guarded. Motions of spine practically normal. Over the upper part of right buttock just below crest of ilium is an indurated area, elastic to touch, suggesting a possible bursa or some process developing in the wing of the ilium. Complains of pain in knee and hip, particularly at night.

Exploratory incision advised.

An incision was made into the swollen region and a very extensive hæmorrhage was encountered which was only controlled by packing. Following this operation the patient was relieved for some months. Finally however in the fall of 1904 he died with all the clinical symptoms of sarcoma. The tissue removed at operation showed an osteosarcoma.

**Case XIII.** — Mrs. H. Age, 52 years. Diagnosis. — Carcinoma of ilium.

Patient was complaining of pain in the lower back and right leg. The thigh was flexed upon the abdomen at nearly a right angle and had been so for two or three weeks. She had been gradually failing for some months, but had had very little pain until six weeks before she was seen. The pain became so unbearable that it was necessary to use a considerable dose of morphia in order to keep her comfortable. Five years previously she had developed a carcinoma of the uterus, for which she had an operation consisting of a resection of the cervix uteri. She had lost much weight, had no appetite, slept very little, and was very anæmic.

On physical examination the patient permitted no motion at the right hip because of pain. Spinal motions were slightly restricted, but because of the difficulties in making a physical examination with a leg flexed to the degree of hers it was impossible to determine whether the restriction was pathological or was due to the position of the leg.

On abdominal examination there was some fulness in the right iliac fossa and an apparent thickening of the iliac bone deep down in the pelvis.

An exploratory incision was made into this region and on exposing the ilium well back toward its juncture with the sacrum, a softened area was found in this bone, and tissue removed from this location demonstrated on histological examination the existence of an osseous carcinoma of the same type as that which is commonly seen in carcinoma of the cervix uteri. No removal of diseased bone was feasible and the patient died after three months of suffering from carcinomatous metastasis.

**Case XIV.** — Mr. O. C. Diagnosis. — Sarcoma of femur. Paget's Disease. July 26, 1902. — 62 years of age.

Family history negative, except that a brother has "rheumatic gout."

At twenty-five years of age he himself had an acute attack of gout

in one foot. For the next twenty years he had no difficulty of this nature; then had a second attack in the same foot, and since then has had frequent attacks in the feet and one knee. Six years ago he had an attack of aphasia. He now finds that it is very difficult to go over the stairs, or to assume a standing position, and has noticed during the last five years that his knees have been gradually flexing. He is  $1\frac{1}{2}$  inches shorter than he was thirty years ago, his present height being 5 feet,  $9\frac{1}{2}$  inches.

Physical examination. — Well-nourished man. Marked bow-leg with anterior as well as lateral bowing. The left tibia is markedly thickened in its upper half as is also the left femur. The right tibia and femur are also involved, the latter being bent more than it is thickened. Both knees show an increase in surface temperature. No trouble in the hips. Length of legs the same. The right arm cannot be fully extended at the elbow and the upper half of the right radius seems thickened.

June 10, 1903. — Was in Southern California all winter (1902-03). Ability to walk and stand is less than last year. Legs are weak and has pain in his back. Height, 5 feet 8 inches. Both legs have increased their bow, particularly in the antero-posterior plane.

November 23, 1903. — Disability is increasing.

September 9, 1904. — During August of this year (1904) the trouble in the left knee underwent a sudden change, and swelling developed over the lower end of the femur without any evidence of joint disease. A hard mass could be felt in the popliteal space and at the side of the lower end of the shaft of the femur. X-ray suggested sarcoma. A week later measurements showed that the tumor had increased in size. Amputation was advised and was performed by Dr. F. B. Harrington a few days later. The clinical diagnosis of sarcoma was confirmed. Patient died a few weeks later

**Case XV.** — Mr. A. O. W. 65 years. Diagnosis: Sarcoma of ilium.

October 17, 1903. Complaint, pain in right lower limb. Duration, six weeks. Cause, unknown.

Symptoms began with a little tenderness in right groin, gradually





FIG. 185. This specimen was X-rayed after amputation. The new growth in the popliteal space is very marked. Case XIV.

increasing to pain in different areas of the right limb. Slight limp for last two weeks. Has not been able to walk any distance for one month. Can ride wheel without any discomfort. Had sciatica twenty years ago.

Physical examination. — Inclines a little to right. Slight atrophy of right buttock. Right thigh flexed a few degrees and motions which involve attempts to hyperextend the thigh are very painful. Motions at hip guarded a little in rotation. Spinal motions quite free with no spasm.

October 22, 1903. — Bandage has been worn only part of time. Sleeps poorly from uneasiness because of bandage. Walks better. Hyperextension of leg more free, but is still unable to raise leg when lying down. A distinct fullness just below Poupart's ligament on right in middle of groin. Continue bandage.

December 17, 1903. — Not as well. Walks with right leg abducted and flexed. Pain chiefly in right leg but some about left hip. Spinal motions in the lumbar and low dorsal regions much limited. Bending to left impossible. Hip motions free except complete extension. Is sleeping very badly. Reflexes normal. Condition suggests some spinal disease, probably osteoarthritis. Jacket.

December 26, 1903. — Jacket applied.

February 8, 1904. — Has been very miserable since last note. Has worn jacket. Very little sleep at night except with morphia. Walks with much limp and with right leg abducted. Spinal motions free to right, very little to left. Fullness in right iliac fossa and also at or below Poupart's ligament. Suggests disease in region of ilium, either glandular, bursal, or sacro-iliac. Marked atrophy of both buttocks.

April 13, 1904. — Patient has been through a period of much suffering requiring morphia quite constantly and has had much difficulty in getting about. The spinal motions continue to be restricted, but with more or less variation. No kyphos. The thickening which has appeared about the wing of the right ilium anteriorly suggests either an abscess or new growth. The X-ray showed disease, apparently a caries of the right side of the sacrum. Psoas contracture remains. Of late

pain has lessened and ability to walk unaided has returned. Generally is much better. Wears a webbing corset for support.

October 19, 1904. — Is wearing a webbing corset and flannel spica about the hip. Walks lame in right leg as if leg were short. Since April, 1904, has been about as now. Tenderness and pain is referred to the anterior part of right groin. Hip motions free. Spine fairly so. Tenderness and swelling over right sacro-iliac articulation. Fullness in right iliac region suggesting a large psoas abscess or new growth. General health good.

December 20, 1904. — Four weeks ago pain started in right hip with swelling. This has increased and there is now some pain in left hip. The swelling at the inner side of the ilium remains. On the outer side of the thigh, extending round to the front, there is a large swelling, which is hard and apparently very vascular. He is still able to walk about.

Patient subsequently died, the result of a sarcoma in the sacro-iliac region.

**Case XVI.** — J. S. Diagnosis. — Sarcoma of right patella. September 11, 1905. Age, 19 years. Complaint, "pain in right knee."

Family history. — Mother and father living and well. Two brothers and three sisters living and well. No tuberculosis, cancer, or joint trouble in the family anywhere that he knows of.

Personal history. — Enlarged glands of neck when a child. Denies venereal.

Present illness. — Patient was perfectly well up to the 20th of last July (1904), when he was kicked in the right knee by a horse. Two days after this his right knee began to be intermittently painful. The pain was not worse at night, but was aggravated by walking. At this time the knee was not swollen, red, or hot. In December he noticed the joint was swelling, and it became painful and somewhat sore. The pain and swelling gradually grew worse and a month later he was forced to cease work. He went to a hospital, where he was treated with adhesive strapping and splints for two months without relief. He has lost 15 lbs. in weight since December, 1904.

Physical examination.—Well developed but rather poorly nourished boy. Examination of heart, lungs, and abdomen negative. Glands in each groin moderately enlarged. One in right groin size of a chestnut. Right knee shows considerable diffuse swelling which is of boggy consistency. The patella feels soft and cartilaginous and is about three times its normal size. Some soreness to pressure about the knee, but this is not marked. No redness or heat. No excess of fluid. Motion in flexion to  $10^{\circ}$  beyond a right angle without pain. No permanent flexion or subluxation. Some crepitus felt on motion. No lateral motion allowed.

Measurements show length of legs to be equal; 5 cm. atrophy of right thigh; 1 cm. atrophy of right calf.

September 13, 1905.—Operation (ether). A curved incision one inch in length was made on the inner side of the right knee from the internal femoral condyle towards the lower border of the patella. The tissue about the joint proved to be very vascular. Careful dissection with the scalpel and blunt dissector exposed the capsule and this was perforated and slit open with the scissors. The surfaces of the articular part of tibia and femur looked normal, but the patella proved to be much enlarged, soft, and very spongy. There was no fluid or caseous substance in or about the joint. The incision was now extended an inch and the slit in the capsule made larger and the edges of the wound retracted. The mass in place of the patella was grasped with double hooks, and dissected out with scissors. Patient commenced to show signs of shock. Bleeding vessels were all hurriedly tied and the joint washed out with hot sterile water, a wick inserted and skin wound sewed up with continuous silkworm gut. Large sterile dressing.

Diagnosis.—Giant-celled sarcoma.

**Case XVII.**—S. L. S. Interarticular sarcoma (knee).

June 13, 1905. Complaint, right knee. Duration uncertain: probably six or seven years. Cause, attributed to a fall from a bicycle, but injury is very indefinite.

First noticed a swelling on the inner side of the knee, not definitely

localized but apparently not osseous. Never any acute swelling. Has not been confined to bed. A slipping sensation has been referred to the inner side of the knee and this has not infrequently caused him to fall. Walks on the side of his foot in order to favor his knee. The front of the joint is tender to very slight injuries, and he is often kept awake at night because of aching in the knee, which is somewhat relieved by changing his position. The boy states that when the knee locks he has to take both his hands and flex the leg before he can extend it.

Physical examination. — Pain referred definitely to just above trochlear surface of the femur on the inner side. Contour of the knee not particularly changed. Horizontal extension impossible without assistance because of pain referred to the above-mentioned point. Right knee is a half inch smaller in circumference both over the patella and above it. On extension and flexion pain is referred to the same point, but hip and knee motions are perfectly free. Walks with right knee slightly flexed and with foot considerably pronated. Right leg three-eighths of an inch shorter than the left. Operation advised.

Operation. — Vertical incision three inches long over inner condyle of the right knee just inside the patella. Joint opened and a tumor mass  $1 \times \frac{3}{4} \times \frac{1}{2}$  inch found lying close against the femur at the edge of the patella and beneath the synovial membrane. This was excised, and the wound was closed with silkworm gut in the skin and silk in the capsule. Examination of the tumor showed a spindle-celled sarcoma. Convalescence has been uneventful.

January 3, 1907. — Is having no trouble in the joint, using it freely all the time, and there is nothing in the examination to suggest any return of the disease.

## CHAPTER VI

### HYSTERIC AND FUNCTIONAL JOINTS

IN a study of the diseases of bones and joints, conditions are frequently met which simulate very closely organic lesions. Some of these have had a traumatic origin, some have been preceded by organic lesions, and still others, by far the least in number, are purely neuro-mimetic or hysteric. In the latter class of cases the local symptoms are so conspicuously associated with evidences of a general neurosis that any one at all familiar with the symptoms of joint disease is not likely to be deceived. The really difficult cases are those where previously existing organic lesions, though apparently entirely quiescent, are still a possible explanation of the perpetuation of functional disturbances.

At the present time, when so great demands are being made upon the vitality of the individual in order that he may maintain his place in the world's competition, there is little reserve force to be called upon and consequently there are more wrecks of the nervous system than there were when civilization was less complicated and competition less keen. There can be no doubt that this condition of affairs has had much to do with the prevalence of functional disorders which manifest themselves in the joints, as well as generally, by a loss in tone throughout the muscular and ligamentous structures.

In those cases of arthritis where the initial lesions have been severe or where convalescence has been protracted, particularly if the patient is of a neurotic temperament, there is great danger that progress will be retarded by the development of symptoms which are not organically connected in any way with the original lesions. That which hinders in these cases is not pain in the affected articulations, nor impairment of function, but the loss of an intangible

element of moral initiative in the patient. Inability on the part of the medical attendant to supply this explains why, in so many cases, these patients can attain only a certain amount of improvement under the care of the regular physician or surgeon and yet manifest most extraordinary gains when they make a change in their medical adviser, even though such change may be to the veriest tyro in therapeutic knowledge or to the worst type of charlatan.

This condition in a greater or lesser degree is almost constantly associated with the problems of treatment which are presented by chronic polyarticular diseases. It is not fair to speak of these patients as psycho-neurotics and yet they may develop into such under certain circumstances. In helping them to work out a cure in the more severe types of polyarthritis it is of great importance that this phase of treatment should occupy a prominent position. The moral support of a strong personality is often quite as effective as splints, massage, or other therapeutic agencies.

At the same time as opportunity for the study of these functional conditions has increased there are many observers who find less and less ground for the belief that because these symptoms give evidence of psycho-neuroses they are purely functional, and more and more reason to regard them as having some physical basis. This conception of the matter makes it evident that treatment, to be wholly successful, must not ignore the physical at the same time that it takes cognizance of the psychic side of these problems.

Traumatic neuroses of the various articulations have received the most minute consideration at the hands of the neurologists. The majority of patients who suffer from such conditions have received injuries for which they are seeking redress from some source which they regard as responsible. They commonly exaggerate all the physical disabilities which may result from the given injury, and in addition to this present a train of symptoms referable to the central nervous system which deprives them of the exercise of many of the higher mental faculties, as concentration of attention, ability to reason logically, and control over emotional faculties and memory. As a result of giving up to these auto-suggestions, the physical con-

dition of such patients is often seriously affected. The counter-suggestion which is involved in a favorable settlement of their damage claims is capable of producing as striking evidences of improvement as their injuries were able to do in developing symptoms.

Even without history of definite injury individuals whose nervous force is at a low ebb and who in consequence of this are lacking in muscular tone, are frequently subject to a train of symptoms, referred, as a rule, to some particular part of the body. These may closely resemble the symptoms of organic lesions. When as often happens there is a slight derangement of normal anatomical relations, it is very easy for the individual to magnify suggestions which come from the outside or from his own consciousness until they assume the proportions of a controlling impulse. When there are added to this condition extraneous causes for fatigue, brought on through excessive mental or physical exertion, then it is not a long step to a psycho-neurotic condition. The gynæcologist and the oculist are constantly meeting with examples of this combination of expended nervous force and imperfect anatomical relationships. The customary way to treat these conditions in former times has been by attempts to set right the faulty anatomical relations and for this purpose recourse was had to operative procedures or supports for pelvic viscera, and corrective lenses for the eyes, often ignoring the loss of muscular tone which was conspicuous among the symptoms and which no amount of special treatment could possibly more than temporarily benefit. The causation of these conditions is now more fully appreciated and the basis of treatment has changed. Many ptoses of the abdominal viscera which formerly were treated by artificial suspensions are now managed in quite another manner. The psycho-neurosis which has so often been noted as an accompaniment of these anatomical displacements is now assigned its proper relative place. It is no longer regarded as a sequel of the anatomic displacement, nor is it merely a coincidence, but may be in reality a causative factor in the production of such lesions. Under the conception of the relation of functional and psycho-neurotic symptoms to anatomic lesions, to which reference has just been



made, the surgeon looked upon the anatomic misplacement as a source of irritation which was reflexly responsible for the entire train of functional disturbances. Treatment, therefore, contemplated the removal of this source of irritation for the very same reason that one removes a cinder from the eye. From such treatment the surgeon expected and led his patient to expect effects which often were not justifiable. That there are possible reflexes from peripheral irritations which may hinder the progress of a patient whose symptoms have their chief basis in functional disturbances, there can be no doubt. The error lies in ascribing to these irritations the entire rôle in the causation of such symptoms and in being satisfied with treatment when removal or correction of such irritation has been accomplished.

What has just been said applies with most force to the field of gynecology and general surgery. It is however with only slightly less justification that joint diseases and the deformities which may result from them can be so considered.

The surgeon whose practice brings him in contact with diseases of the joints is constantly brought face to face with problems of this nature. Aside from functional disturbances which may be associated with joint disease there are certain groups of symptoms which are the result of relaxations of particular muscular groups and the ligaments which hold together the more important articulations. The primary cause for these relaxations is incapable of determination in many cases. There may have been acute sickness and protracted convalescence, leaving the patient in poor general condition, emaciated, anæmic, and therefore without muscular vigor. On the other hand, without any acute sickness and in spite of the external evidences of health, viz.: good color, good nutrition, and sufficient vitality to permit the performance of an exacting daily routine, the same train of symptoms may be developed. Individuals who inherit neurotic temperaments are predisposed to these conditions. One often finds on careful inquiry evidence of organic nervous disease. A history of sick headaches, migraine, and insomnia are of frequent occurrence. Sedentary habits, faulty atti-

tudes in sitting or standing, and actual deformities are occasional contributory factors. Careful study of these patients has revealed certain fairly constant symptoms which are indicative of organic lesions, and though in general the organic lesion has only a minor causative influence upon the symptom complex of this class of cases, yet because of the interference with locomotion, sleep, and other functional activities essential to the normal metabolism of health, these lesions are of more importance in treatment than they are significant in etiology. It is therefore necessary to devote particular attention to the joint symptoms of patients in whom prolonged muscular weakness, brought on by neurotic conditions, has produced joint irritation and strain.

The most common type of neurosis which comes to the orthopaedic surgeon is that in which the symptoms are largely referable to the spine. The irritable, hyperæsthetic back is very common, and is perhaps associated more constantly with psycho-neuroses than with any other one symptom or set of symptoms. The beginning of the trouble may be associated with traumatism to the spine or it may follow in the course of the development of a train of general functional disturbances. The patients are almost always women, more frequently unmarried. Temperamentally they are impressionable, high-strung individuals, and have rather less than the normal amount of physical vigor. Occasionally there is among them a slow, phlegmatic person or one whose physical vigor seems unimpaired. They are characterized by the readiness with which they respond to suggestion and the ease with which they become fatigued. They are usually thin and more or less anæmic; they are poor sleepers and without appetite except for the un-nourishing articles of diet. In spite of professed inability to withstand slight use of their muscles, tasks requiring the exercise of surprising amounts of strength will be undertaken and accomplished when one would hardly credit the patient with being able to carry them through. They are often jealous in disposition, over-solicitous of others' comfort and welfare, and will go to great lengths of personal distress and fatigue in their devotion to those in better health

than themselves. Frequently they are incapable of mental concentration, are morbid in their ambitions, their friendships, and their outlook upon life. Introspection is characteristic of their mental make-up and is at the root of much of their morbidity. They are emotional, easily moved to tears, are suspicious of the avowed intentions of others and consequently of an unhappy temperament. They are frequently the subjects of polyuria or anuria, of constipation or diarrhoea, which conditions may alternate without any ascertainable physical reason. Their morbidity occasionally extends to perverted sexual habits. The greater the degree of physical fatigue of which they complain the more they will undertake that which requires further expenditure of energy. The history often reveals an unstable nervous equilibrium in more or less remote members of the patient's family.

In these spinal types physical examination yields results entirely out of proportion to the subjective symptoms. Muscular tone is generally poor: there are frequently relaxations of ligaments, notably those about the knee joints and the sacro-iliac articulations. Ptoses of abdominal and pelvic viscera are occasionally associated with the more pronounced types. Floating kidney and gastropptosis are the more common forms of visceral displacement. The condition is often aggravated by a weak or pronated foot which is also due to the underlying muscular relaxation. Spinal examination is characterized by normal motions as a rule, by alterations in the physiological curves of the spine resulting either in a markedly round-shouldered condition or one of extreme lordosis. Occasionally there will be a list to one or the other side and an apparent spasmodic rigidity of the spine. This rigidity and list entirely disappear under the gradual application of corrective force or when the recumbent position is taken. There is no permanent antero-posterior deformity. The skin over the spinous processes may be hypersensitive and the patients often wince under the most superficial pressure. The lumbar and dorsal segments of the spine are usually the most sensitive. In patients presenting the foregoing subjective and objective signs there is often considerable variation in the localization

of their most striking symptoms. It is not a far cry from a condition of this sort to the more profound neuroses which have distinct hysterical stigmata.

These patients are among the most difficult to handle of all the chronic cases coming into the hands of a physician. Because of the localization of many of their symptoms in the region of the spine or large joints they often seek orthopædic treatment. They more frequently fell in the past to the lot of the gynæcologist. In either event the reason for their coming is usually one of two things, — either the family physician can do nothing with the case and does not care to try, or else he believes that there may be some physical basis for all these symptoms.

The danger of attributing too much significance to physical defects which may be present in such patients is great. One typical record may serve to indicate the difficulties inherent in the problems of diagnosis and treatment. We quote the history of this patient in her own words. It is of some significance that she wrote it out herself and brought it with her because she conceived that by so doing she would be more likely to put us in full possession of the facts.

Mrs. M., a very intellectual, active woman, has been a school-teacher for many years and was married rather late in life. She sought advice in the first place because of stiffness and discomfort in her neck. The following is quoted without any alteration from her written history:—

“In regard to my past history, the following may be important. All my life I have been troubled with acute attacks of what is called stiff neck. Though my neck was always stiffened at such times the greatest trouble was in my back between the shoulders. A continuous chronic condition of the same nature shows itself in extreme pain in my arms after any continued action of the arms, though my arms are very muscular and stronger for one effort than most people’s. I am absurdly incapable of continued action of the arms even of the slightest kind. I cannot hold a book for reading, nor

can I enjoy looking at anything that requires me to throw my head back. In 1903-05, the nervous pain in my shoulders and arms became so incapacitating that I consulted physicians. I wore a high collar for several weeks and then took physical culture in the gymnasium, and massage. This treatment strengthened me a great deal and I have not had an acute attack of stiff neck since. The incapacity in my arms, however, has been very great.

"I might add here that I am never ill, rarely seriously ailing, but always falling below the amount of endurance and energy which a person of my physique ought to have."

The patient here relates at some length experience with an "osteopath," and following this describes a group of symptoms including stiffness and contractures or "spasms" in the legs and abdomen, which were supposed to be due to a reflex from the appendix, the ovary, or from the rectum, and accordingly she had an operation upon these organs, from which she secured no benefit.

"I should consider myself perfectly recovered except for these spasms. Any one of the four troubles corrected by the operation was supposed to be sufficient cause for the spasms and their continuance was supposed to be reflex. Of the four causes the condition of the rectum was thought to be the most probable. It was examined again under ether on January 2nd, 1907; a pile and a fissure were treated.

"These spasms were not ordinary cramps in which an individual muscle is painfully pulled. They are spasms of rigidity in legs, arms, abdomen, and back. They leave the legs and back very lame. Some days I cannot lift my legs without pain; the legs and arms are heavy, and the least exertion gives a feeling of extreme fatigue. I have seen the dog while lying on the floor stretch out his four legs until they were rigid and until his body vibrated with the tension.

"I have such impulses and cannot resist the effort although it is followed by complete exhaustion.

"My general health has not been as good since as before the op-

eration. My legs and arms are weak. I get tired easily and for the first two weeks of every month there is more soreness in the region of the ovaries than there has ever been before. I have always had periodic headaches and they are better if anything. After these first two weeks are over I feel very well and enjoy life in any way that comes to me, but I reach the limit of my strength soon. I sleep and eat perfectly. I belong to a long-lived, healthy race, have fine lungs, a good heart, no scrofula, or hysterics, and am not a nervous person. Nature intended me to be strong."

The foregoing is fairly typical in its essential characteristics of many of the histories given by patients suffering from psychoneuroses.

Whenever this patient was examined there were practically no physical signs pointing to any lesion. Her subjective symptoms have led to the examination of nearly all parts of her anatomy. Symptomatic treatment has made a conspicuous failure in every instance.

The reference of symptoms to the spine and the contractures of muscles of the neck are often the most suggestive orthopædic symptoms. The futility of surgical interference in such cases is indicated by the results as she reports them, and this is quite in accord with the results in a majority of cases of this type who are subjected to surgical operations with the expectation of a cure.

The second case is cited as illustrating the frequent assumption of symptoms pointing to the joints and other parts of the bony skeleton. This case had many of the stigmata of hysteria.

Miss A. McG. Age, 23 years.

In October, 1897, patient was separating two boys, pupils in her school, who were engaged in a fight, and during the scuffle one of them bit the middle finger on the right hand. It was a comparatively trifling wound and was entirely healed in about three weeks, but she was taken to a Hospital on January 25th, 1898, because of the development of acutely painful symptoms in the forearm of this hand which seemed beyond control, either inside the Hospital

or out, by any therapeutic measures which were tried. She remained in the Hospital from that time practically continuously for four years, the greater part of the time as a patient, some of the time as a general utility person.

Shortly after her entrance in 1898, she was seen by the consulting neurologist who made a diagnosis of ulnar neuritis.

Later in the spring of that same year she developed symptoms of cerebro-spinal meningitis. She had an irregularly high temperature and many cerebral symptoms. It was thought possible that these might be caused by an inflammation in the middle ear, and accordingly the aurist of the Hospital was asked to see her, but he found no cause for her cerebral condition in the ear. This was in April, 1898.

Shortly after this, the cerebral symptoms having disappeared, and the right hand having contracted so that the fingers would flex sharply upon the metacarpals and the wrist upon the radius, the surgeons etherized her and manually extended the fingers and the wrist without any especial difficulty, and put them up in a palmar splint. Again this was done on June 28th, and later on August 21st, both times under ether. Each time immediately upon removal of the splint the contracture recurred.

During the six months succeeding August, 1898, she wore a splint constantly and complained as constantly of pain in the forearm and hand, but she was able all this time to conduct the music of the Catholic Church for all functions of the Church at the Hospital Chapel.

In March, 1899, she was transferred to the Orthopædic Service, and her hand was manipulated on two separate occasions under an anæsthetic with results like those which had previously been obtained.

In rapid succession she was then seen in consultations by members of the Medical staff and of the Gynæcological staff for symptoms which pointed to some general medical disturbance on the one hand and to some pelvic difficulty on the other. Nothing definite was made out by any of the three gentlemen who saw her.

At about this same time she began to have severe pain in the feet and ankles. They would swell up to an enormous degree within a comparatively short time and the swelling was accompanied by much pain and redness, and during a period extending over eight or ten months it was necessary to keep her in plaster, and she walked about with a very cumbersome plaster boot, but without which she rigorously maintained she could not step. During this period she also was on the surgical service because of symptoms which pointed to gall bladder inflammation, and only escaped having her abdomen opened on two or three occasions by a marvelous recovery from the acuteness of her sufferings.

On January 7th, 1900, the feet were manipulated and a tenotomy of both Tendones Achillis had to be done before the feet could be put up at right angles with the leg

From this time until 1904 the hand remained as it had been, contracted, and showing a tendency to greater contracture at the wrist. Three or four times for short periods she had to go back into the plaster boots on account of pain in the ankles, but otherwise there was nothing new.

The pain and contracture gradually increased during 1901, 1902, and 1903, and finally in 1904 the forearm was amputated because of the persistence of pain and contracture. Since that time there has been practically no pain in that extremity, though the feet have occasionally caused some inconvenience. She continued her duties as organist at the Hospital after the arm was amputated, exhibiting marvelous technical skill.

In the latter part of 1904 she developed symptoms referred to the shoulder and arm on the side of the amputation, and the presence of a cervical rib was suspected. An X-ray seemed to add some evidence in substantiation of this opinion and she was subjected to another operation with a view to removal of the rib. No supernumerary ribs were found, and immediately after this operation she manifested a most extreme type of spasmodic torticollis associated with great pain and not relieved by any amount of therapeutics.



She was then again transferred to the Orthopædic Service. A plaster helmet including the thorax, the neck and head was applied under ether and the head was found to be freely moveable when the patient was profoundly anæsthetized. The head was put up in over-correction. The patient voluntarily broke the first plaster and two days later the helmet was reapplied. This time the plaster held and during the next four or five months it was necessary to change it twice, but neither time was an anæsthetic necessary. At the end of that time the head showed no tendency to revert to a torticollis position, and so far as the head and neck have been concerned since that time there has been no trouble.

She left the Hospital because she was in such good health and has been living during the summer and fall of 1907 and a part of 1906 outside the Hospital, but continuing her official duties at the Hospital as organist.

In November, 1907, she was readmitted to the Medical Service on account of a gangrenous erythema or an erythema multiforme; a most alarming condition was present all over the face and neck for nearly ten weeks. This has gradually quieted down and the patient is now in as good health as she ordinarily enjoys. She was out of the medical ward scarcely a fortnight before the right ankle began to swell and cause pain and it became necessary to go back to the use of a plaster of Paris boot.

**Hysteric hip.** There is still another variety of neurotic lesion, seen perhaps more often in the hip joint than in any other articulation, in which there is much complaint of pain on use of the joint. These cases are met usually in young adolescents, most often girls. The objective signs are those of tuberculous disease of the hip joint. The patient walks with a more or less marked limp and often with a decided list of the trunk toward the side upon which the limp occurs. There is no shortening of the limb; there may be a slight amount of atrophy of the thigh and calf. The passive motions at the joint are guarded by a simulated spasm which simulation it is generally possible to recognize as such because it is impossible

for the patient to consistently keep up the deception, and in some unguarded moment she will fail to resist attempts at motion although she has done so just previously. At times however it is necessary to administer an anæsthetic to clear up the diagnosis. The general picture is not often that of a true arthritis and the history will often yield facts suggestive of a neuro-mimesis, or other stigmata of hysteria. The character of the subjective symptoms will oftentimes give a clue to the correct diagnosis. These cases are best treated by suggestion, combined with apparatus, e. g., plaster spicas, and by compelling the patient to perform gradually increasing amounts of physical exercise requiring the use of the affected leg.

## TREATMENT

Having arrived at a conclusion as to the ratio between the organic and neurotic factors in a given case, the question of treatment becomes paramount. Purely symptomatic treatment is generally a failure; purely psychic treatment is often attended by brilliant results, but its permanency cannot be assured. Just now the latter method is being popularized to an extraordinary degree. In churches and settlement work clinics for the psychic treatment of nervous disorders are the vogue. Recognition of the importance of this element in treatment has been forced upon the medical profession at large and upon the public in general by the practice of the Christian Scientists particularly. There is great danger however in adopting this principle as the only one. The writers believe that demonstrable or even probable anatomic and pathologic defects should be corrected, since they may well represent a constant source of aggravation to the psycho-neurotic condition

For purposes of convenience we will treat this phase of the subject under the following heads, viz.: (1) Mechanical appliances; (2) physical and drug therapeutics; (3) operative treatment; (4) "rest" and "work" cures; and (5) psychotherapy.

## MECHANICAL

The place of mechanical supports in the treatment of functional joint troubles is often a very important one. The muscles controlling the motions of a joint, or a series of joints like those of the vertebral column, are fatigued by even a slight exercise of their functions, and in the extraordinarily receptive state of the nervous system of these patients the response to this peripheral fatigue is a deepening of mental inertia. The patient is more and more disinclined to make any physical effort, and metabolic faults are added to those of the nervous mechanism. In order to conserve muscular energy and spare the central nervous system from any unnecessary tax until some reserve force has been accumulated it is desirable to have recourse to the use of apparatus. There are also certain physical discomforts, the direct result of relaxation and loss of muscular tone, which it would be desirable to alleviate under any circumstances, whatsoever the cause, and which it is all the more worth while to give attention to in neurotic patients. The parts of the body where symptoms are most prone to arise which require attention of this sort are the spine, the sacro-iliac joints, the knees, and the feet. Support of a pendulous abdomen and correction of various ptoses of the viscera are required in many cases at the same time that the relaxations of the joints are undergoing treatment.

In the **spine** there are often extreme degrees of postural deformity, which result partly from muscular weakness and partly from the irritability of the intrinsic musculo-nervous mechanism of the vertebral column.

In the more extreme types a plaster jacket is advisable for a time, to be followed by a less rigorous support as improvement takes place.

It might be supposed that such treatment would be so abhorrent to a hypersensitive spine that no good would be accomplished and the physical discomfort would only be aggravated. There is doubtless a certain amount of suggestion which goes with the employment

of a plaster jacket for such purposes, but this is also true in regard to the use of apparatus of any sort in cases of this kind. The more suggestible the patient the greater will be the benefit from the apparatus. Apart however from the influence of suggestion the braces employed have a definite, physical, beneficial effect. After a few weeks' wearing of a plaster jacket in cases where the severity of symptoms demand it, a light spring steel back brace may be substituted and this should be continued as long as spinal hyperæsthesia persists. During this period medical gymnastics and other desirable forms of physical therapeutics may be carried out. The writers have had a young woman under their care who came from the Barbadoes, where she had been kept in bed for two years by a severe attack of nervous exhaustion. At the end of that time she fell into the hands of a practitioner who believed she could be helped by wearing a jacket, and he accordingly applied one after the manner of applying plaster of Paris jackets then in vogue in those islands. Two red flannel undershirts were put on, one immediately outside the other, and between these two layers of flannel was poured a thick plaster, which was moulded and more or less unevenly distributed by the hands. After the application of this she got up and took steamer for this country, and when seen she had worn this jacket, which weighed eighteen pounds, for over a month, and was much better. It was only necessary to continue this principle of treatment in a somewhat modified form to restore this patient to a fairly good degree of health. Certainly in this case suggestion must have played a very important part. The wearing even of red flannel in the Barbadoes must require some faith.

In case the **pelvic articulations** are the seat of relaxations which apparently contribute to functional disability the principles of treatment which are outlined and illustrated in the chapter on Sacro-Iliac Disease should be followed. Adhesive plaster strapping gives us a very effective method of applying support to these articulations. Where skins are sensitive and easily irritated by the use of adhesive plaster, other methods of support must be employed. In applying the plaster it is better to use broad strips, two and one-half to three

inches wide. These should extend across the back one overlapping the other posteriorly from the level of the trochanter to the anterior superior spine. They should not extend so far anteriorly that when the patient is seated there may be danger of excoriation of the skin from too great tension of the straps. This will usually require from four to six such strips and they should be put on under considerable tension. If not brought in contact with much water they will generally hold effectively for ten days to two weeks. A belt of similar dimensions may be made of the elastic material which forms the tops of Congress shoes and is known as "Hub Gore" in the shoe trade, or a reinforced heavy "drill" belt attached to the bottom of the corset and capable of being strapped tightly about the pelvis. Silk-elastic trunks have also proved serviceable in many cases of this sort. In all these appliances there should be no severe lateral pressure exerted on the crest of the ilium, since compression of the pelvis tends to separate the sacro-iliac joints at the bottom. The therapeutic principle involved in their use is the same as in the employment of jackets and braces in the form of spinal irritation above referred to, viz.: support of relaxed ligaments and removal, physically and through suggestion, of a cause for the perpetuation of nervous symptoms.

The **knees** are not so frequently the seat of functional symptoms as is the spine, but in a certain number of neurotic patients relaxation of the supporting membrane of the joint causes the synovial membrane to drop down so that it becomes pinched, and pain and interference with function, with the consequent ill effects upon the nervous features of the case, ensue, and it is oftentimes through treatment of these local symptoms that one contributing cause of the psycho-neurosis can be eliminated. Strapping with adhesive plaster, followed up by hydrotherapy and massage, combined with removeable splints of pig skin or some form of cotton elastic or flannel bandage, reinforced by strips of felt to increase its support to the knee, are the most effective methods of treatment of functional symptoms in this location.

The **feet** and **ankles** are very often the seat of symptoms. Relax-

ation of the supporting ligaments and muscles of the ankle and tarsus results in the development of flat or weak feet, if not of the organic type, at least of a variety which can with difficulty be distinguished from it. This condition is very frequently associated with relaxation of the capsule of the knee joint.

Mechanical supports for the arch, Thomas heels to correct defects in weight-bearing, and exercises to improve the muscular tone of the intrinsic muscles of the feet and those muscles of the calf of the leg which are concerned in the maintenance of the arch are instrumental in overcoming local symptoms in these patients.

### DRUG TREATMENT

Associated with the functional joint disturbances of these patients there are many symptoms which are not dependent in any way upon the supposed lesions of the articulations. These in the minds of the patients seem to require medicinal treatment and they are oftentimes best managed in this way. The commonest of these symptoms are intestinal. They are either profoundly costive or are greatly troubled by nervous diarrhoeas. Frequent, watery dejections, usually spoken of as mucous colitis, are a common complaint, or the two opposite conditions may alternate without reason. This habit must be controlled in some way. Regulation of diet, for oftentimes the patients believe that some particular error in dietetics will produce it, is at times necessary. Systematic lavage of the lower bowel with cold injections is often beneficial and is to be preferred to the administration of drugs. If the latter are used subgallate of bismuth or some of the carminatives may be helpful. Care should be exercised to exclude the possibility of some bona fide cause for a fermental condition in the gut. Constipation may be regulated by the institution of regular habits, by the ingestion of stewed fruits, whole-wheat breads and other articles of diet leaving a coarse irritating residue. Abdominal massage, exercise, and if drugs are employed, those which tend to tone up the intestinal musculature, will be found of the greatest assistance. A little strychnine is often beneficial. Oil enemata, beginning with

pretty bulky amounts, and systematically lessening the quantity, will in many cases lead to correction of the habit. These patients are likely to have very capricious appetites. They crave non-nutritious foods and often will refuse to eat enough to provide themselves with adequate nutrition. Forced feeding is usually necessary, such selection being made as will have a sufficient caloric value, and it is usually best to administer this in small quantities and at more frequent intervals than food is generally consumed. The appetite may be stimulated in some individuals by the administration of tonics, such as some form of iron, arsenic, and strychnine. A preparation containing bicarbonate of soda and the compound infusion of gentian has proved beneficial. Iron in some readily assimilated form is necessary in most cases, because these patients are frequently anæmic. Sleeplessness is a common characteristic in such conditions and is quite difficult of management. It is a good plan to encourage taking something mildly nutritious, and preferably in the form of a hot liquid, just before retiring. Massage at this time and an alcohol or arnica rub-down will frequently yield satisfactory results. Much may be done in this connection by proper management of rest periods, diversions, visitors, and occupations during the day to bring the patient up to the period when sleep is expected, in the proper frame of mind.

In extreme cases and failing in other ways it is permissible to resort to an occasional sedative, as trional, sulphonal, or some one of the newer hypnotics. As a rule however dependence upon these is to be deprecated. Headaches, facial neuralgias, etc., are occasionally dependent upon local causes in the eye, the ear, or the throat and nose, but as a rule are due to general causes and are best treated by suggestion. If however any reasonable doubt exists as to the possibility of an organic lesion, examination by the appropriate specialist should be advised. Polyuria and anuria are conditions often associated with neurotic states. Aside from eliminating the cause for this, which might be dependent upon physical peculiarities in the urinary tract, or qualitative changes in the urine itself, they may be ignored except for suggestive treatment. Rest periods

should be insisted upon during the day and will be much more efficacious if the patient is compelled to undress. Assumption of a recumbent position upon a couch with the clothing on falls far short of producing the desired result. Exercise in small amounts, which shall be gradually added to as the patient's condition permits, is a *sine qua non*. Life in the open air, sleep in a tent where quiet may be assured, and exposure to the direct sun rays are very desirable adjuncts in treatment of the psycho-neurotic.

#### OPERATIVE TREATMENT

The place occupied by this measure in the treatment of the secondary lesions of functional origin is rapidly growing less. Ptoses of the abdominal and pelvic viscera, which used to be so frequently subjected to the surgeon's knife, are now left alone unless there is some demonstrable lesion coexistent with the misplacement, which, though not vital, may be instrumental in preventing constitutional improvement, either in virtue of the disease itself, or its reflex action. The effect of operation undertaken for other cause than that above mentioned is usually to force the patient into a more profound state of invalidism.

#### "REST" AND "WORK" CURES

Two distinct and diametrically opposed principles have been in vogue at different times in the treatment of functional nervous disease. The first is the "rest cure," which is associated with the name of Dr. S. Weir Mitchell, and the other is the principle formulated chiefly by the French, and which is the "work cure." Under the personal supervision of Dr. Mitchell remarkable cures were often wrought, and yet that principle is not capable of universal application. Confinement to bed, forced feeding, separation from all the excitement of seeing friends and from contact with the outside world, is essential in some cases, and when such treatment is combined with the incentive of a forceful personality in the person of the attending physician, much benefit may be derived. It however need not be kept up indefinitely, and should be followed, as soon as



the patient has stored up some reserve nervous force, by certain definite active exercises and participation in mildly distracting pleasures, and later still by physical and mental activity. In some of the more profound psycho-neurotics, in whom there are arthritic symptoms, it is occasionally necessary to begin treatment in this way. Sanatorium life is frequently best for these patients because they are here capable of being controlled, and influences detrimental to progress, because of mistaken or divergent ideas on the subject of the proper management of the patient in the patient's family, may be eliminated. Whatever system is adopted there should be one controlling personality in charge, and after a thorough understanding with the patient a definite policy should be outlined, and when once begun no change should be countenanced unless that change comes at the suggestion of the one in control. If the patient is allowed to dictate the policy and permitted, because of disinclination to carry out the suggestions offered, to omit or substitute at will, then no progress in the right direction can be made.

#### “WORK” CURE

The experience of all who have dealt extensively with functional nervous troubles is that primarily occupation for the hands and a gradual assumption of mental activities yields the most satisfactory results. In the more pronounced types the mentality of the psycho-neurotic is almost childlike in many of its characteristics. All the routine of life, even down to its most trifling details, must be planned for the patient. The capacity of thinking for oneself seems lacking. Concentration of mental effort is often impossible. In this state it is difficult to contrive anything which, while supplying an incentive to improvement, does not overtax the weakened nervous supply, and yet absolute inactivity is not continuously advisable. To supply this need some of the simpler handicrafts have been used as a means of getting patients of this sort back to a better nervous state. The primitive arts, such as pottery, basket-making, rug-making, and weaving, besides hammered copper work, provide the opportunity for doing some creative task with the minimal amount of nervous

fatigue, and the patient has the satisfaction of having produced something which has an intrinsic worth because of its beauty or utility. Such work can be carried on in institutions under competent instructors and may be combined with whatever factors of sanatorium treatment it may seem desirable to adopt. Some of the most pronounced cases have manifested signs of permanent improvement only after they have come to appreciate the value of work in the cure of these conditions.

### PROGNOSIS

The outlook for the permanent and complete cure of the functional joint lesions is not good. Few patients ever wholly recover. They require careful supervision constantly. They are liable to overtax their nerve force at any time and bring back serious symptoms. They must be educated to conserve their nerve force and proportion their expenditures in this respect to their income or else be constantly bankrupt. Such individuals should be compelled to take longer periods of vacation and at more frequent intervals than is necessary for healthy individuals. In this way fewer relapses will fall to their lot.

### PSYCHOTHERAPY

The management of the psycho-neuroses which are associated with many of the chronic joint lesions coming to the orthopædic surgeon for treatment calls for much knowledge on his part of psychotherapeutic principles. The treatment of disease has passed through many stages. At certain periods one special system of therapy has predominated over all others. At one time it was drug therapy which had the ascendancy, at another manual therapy, as exemplified in surgical procedures and massage; again hydrotherapy, both internal and external, has been the vogue. At the present time psychotherapy is coming rapidly to the front. It is not a new feature. In fact, there is no weapon for fighting disease which is older. At no time however has it been as intelligently studied by scientific physicians as at present. The fact that heretofore it has

been at times unintelligently employed when practised by physicians or else has been the stock in trade of the charlatan, explains the fact that it has made no permanent appeal to the better equipped members of the medical profession. The occasional opposition of the educated physician or his lukewarmness has undoubtedly been in part responsible for its being kept in the background. In recent times the movement has been identified with the churches or with religious sects, and it is being made much of by them, in order to reach a class of people whom the church desires to influence. It is because of the prominence into which this old principle has been brought through these agencies, and the demonstration of its efficacy in helping certain classes of patients, that the medical profession has been forced to take up with renewed interest the study of psychotherapy. There is grave danger that it will be overdone, to the detriment of its essential truth. E. W. Taylor<sup>1</sup> has emphasized this in a recent article. It is the duty of all medical men to approach the subject, in so far as it may touch their particular interests in medical practice, in an open-minded, but at the same time a critical spirit, tabulating the results of such treatment in order that the germ of unquestioned truth that there is in it may have an opportunity to grow. Wittingly or unwittingly, every thoughtful, conscientious physician has put many of the fundamental truths of psychotherapy into practice throughout the whole history of medicine. The study of psychology and the establishment of psychiatric laboratories, in which psychic states are being subjected to scientific investigation, have given emphasis to the importance of treating psychic conditions by a therapy which is in itself psychic. The trend of scientific thought among the foremost investigators shows evidence of a departure from the restraint of old limitations. Professor C. S. Minot,<sup>2</sup> in an address before the American Society for the Advancement of Science, draws attention to the difference between the philosophical mind and the purely scientific mind in its endeavor to advance the sum of our knowledge. He advocates the study of consciousness

<sup>1</sup> Taylor, *Boston Medical & Surgical Journal*, December 26, 1907.

<sup>2</sup> Minot, *Proceedings of the Society for the Advancement of Science*, 1902.

from the biological standpoint. Scientific research has been loath to go beyond the realm of material things. Philosophy prompts us and psychiatric methods suggest a way in which we may investigate matters which are beyond the merely material and tangible.

The failure to recognize that many of the symptoms coming in the train of organic lesions, as well as certain entire groups of subjective phenomena, are the result of disarrangements and dissociations of consciousness accounts for the shortcomings of much of our medical practice. The error of the religious sects which have taken up the matter and have organized their various cults about this principle as their essential tenet, is that they have gone too far. A rational psychotherapy will unquestionably be developed between these extremes and will find a place in the armamentarium of every well-equipped physician, and the stigma of quack, charlatan, or faddist will no longer attach to the one making use of such measures in his every-day practice.

In former times functional nervous troubles were quite as prevalent as now, and psychotherapy was employed in their treatment. Hypochondria, melancholia, and hysteria have always existed, and if they, then most assuredly the lesser neuroses. Sorcery, exorcism, and other practices were introduced during the Middle Ages to effect a cure of the gyratory, dancing epidemics and other similar manifestations of the prevalent neuroses of those times. From those periods down to the middle of the last century there was practically no attempt at a systematic or scientific application of psychotherapeutic principles. Commencing with Charcot, who was perhaps a pioneer in this line, the French have contributed more than any other nation to the cause of psychotherapy. The works of Dubois, Déjerine, Janet, and the writings of Weir Mitchell, Morton Prince, J. J. Putnam, Dana, Dercum, and Barker are serving to emphasize the importance of this new method in treatment.

The manner of utilizing this variety of therapy in the class of cases under consideration in this book requires a little special study.

The underlying principle involves the establishment in the patient of a rational series of suggestions, which are dependent upon

reasonable associations which follow each other logically in the patient's mind. In order to do this an accurate diagnosis is necessary, and when organic lesions are existent which are complicated by psychic disturbances, the patient must little by little be brought to understand the relation between his organic and functional symptoms and to see clearly that the nervous element is cureable even if his organic troubles should not be entirely relieved. When the gravity of the organic disturbances may be ignored it is permissible to make light of them, but the truth in regard to them should never be suppressed to the extent of attributing to them a wholly negligible character. In proportion however as the psychic predominates over the organic, should suggestion predominate over other methods of treatment. This practice demands that considerable time be devoted to the patient at sufficiently frequent intervals at the outset to ensure the persistence of the influence of suggestion. Talks with the patient covering previous history will often unearth habits of mind which explain the present symptoms, and with this as a guide it may be possible to indicate, in a way appreciable to the individual, the part played by his unbalanced mentality in the development of his symptoms. When this point has been gained the value of establishing a rational psychotherapy will be more apparent to him. Advantage should be taken of even slight improvements from day to day, and they should be drawn to the patient's attention to encourage him in the hope that other symptoms may in like manner disappear.

Prince<sup>1</sup> has described the value of educational methods in the management of the neuroses, and emphasizes particularly (*a*) instruction in the nature of symptoms; (*b*) eradication of fixed ideas and habits.

Barker<sup>2</sup> discusses the application of psychotherapeutic treatment to hysteric joints. He advocates a frank talk with the patient, after a thorough physical examination, during which a prominent position is given to the suggestion that there is no reasonable basis for any other outcome than a favorable one. He believes in the early in-

<sup>1</sup> Prince, *Boston Medical & Surgical Journal*, October 6, 1898.

<sup>2</sup> Barker, *Journal of American Medical Association*, February 2, 1907.

stitution of physical therapeutics, isolation from friends, and not too much local treatment.

For the successful carrying out of treatment by auto-suggestion, G. C. Smith <sup>1</sup> calls attention to four essential qualifications which must be possessed by one contemplating its employment, viz: — (1) A strong personality; (2) thorough knowledge of the patient; (3) considerable knowledge of psychology; and (4) broad, scientific, medical training.

The physician who possesses these qualities and judiciously combines the essence of psychic treatment with whatever other measures seem indicated is the one who will be most successful in the management of the psychic complications of joint diseases.

<sup>1</sup> G. C. Smith, *Boston Medical & Surgical Journal*, August 15, 1907.

## CHAPTER VII

### THE OPERATIVE TECHNIQUE AND MECHANICAL TREATMENT OF CHRONIC NON-TUBERCULOUS JOINT DISEASE

THE reasons for resort to surgical interference in the treatment of chronic non-tuberculous arthritis have been described. The application of measures for the correction of deformities and the procurement of motion in anchylosed or partially anchylosed joints requires consideration.

**Brisement forcé.** The practice of brisement forcé can be made a very fruitless proceeding or a very helpful one, according to the discrimination and skill with which it is performed. The class of cases in which its employment is appropriate has already been discussed. It may be performed with the unaided hands or with the assistance of instruments, of which the genuclast (Figure 186) and the Thomas wrench (Figure 187) are perhaps the most important. If the object in view is merely to correct deformity, expecting to sacrifice motion, then more force may be employed than when motion is anticipated. The method commonly used has been the exertion of all the force of which the operator was capable under primary anæsthesia, and then confinement of the joint which had been operated upon in plaster of Paris. This was removed after three or four weeks and as a rule ankylosis had resulted whether that was the outcome desired or not. Much better results are obtained in cases where motion is to be expected if anæsthesia is complete before force is exerted. By this method the operator has only to overcome the adhesions which have formed or the contractures which have developed and is not obliged to contend with the involuntary muscular resistance of the patient. In this way trauma to the joint is lessened. In performing a manipulation it is desirable to exert the force gradually, evenly, and sometimes interruptedly. It should never be done sud-

denly or unsteadily. The least manipulation that is capable of gaining the desired motion or overcoming the existing deformity is the best. If once carrying the limb through the normal arc of motion

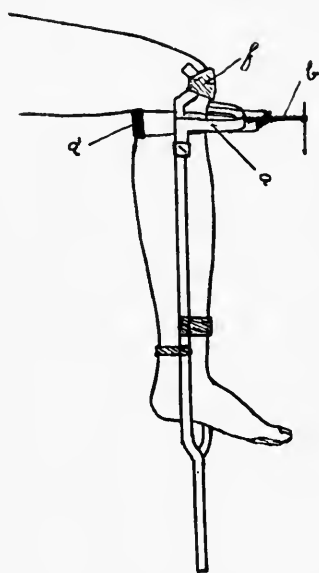


FIG. 186. Showing the application of the genuclast for the correction of flexion deformity at the knee.

is sufficient to accomplish the result sought, further manipulation should be avoided, for that means just so much more trauma to the interior of the articulation. In joints which have been partially flexed and in which an extended position is desired, either with or without motion, it is best to carry the limb as far in flexion as it can be carried before attempting extension. Extension is accomplished more easily in this way than if it is undertaken without this preliminary flexion. In joints where it is particularly difficult to obtain the desired motion it is often better to secure partial correction at the first sitting, holding this gain in a plaster dressing, and a week or so later making a second attempt.

There are several factors entering into the causation of a flexed joint, viz: — interarticular adhesions, either between the apposed synovial layers or between the eroded surfaces of apposed cartilage; contracture of the flexor tendons which, though spasmodically contracting at first, become permanently shortened, or at least shortened in such manner that no mere stretching will overcome their contracture; osseous deformity which may be caused by destructive inflammatory processes in the articular ends of the bones or structural changes brought about by prolonged malposition during growth; thickening of the soft parts on the extensor side of the joint where the interarticular tissue has been stretched; and last of all shortening of the posterior portion of the joint capsule may offer obstruction to extension. Fluid accumulations and villous changes



within an articulation cause permanent flexure, and forcible correction should not be practised for the purpose of overcoming deformity from such a cause. Obviously forcible manipulation cannot be expected to be of equal service in overcoming all these causes for deformity and restriction of motion. Interarticular adhesions may be broken up in this way in many cases. If such adhesions are capsular only, it is usually possible to prevent their re-formation; if they are due to cartilaginous erosions it may only be possible to correct deformity. Shortening of the posterior capsule of the knee joint for example can rarely be wholly overcome by any one manipulation but will often stretch out after manipulation and

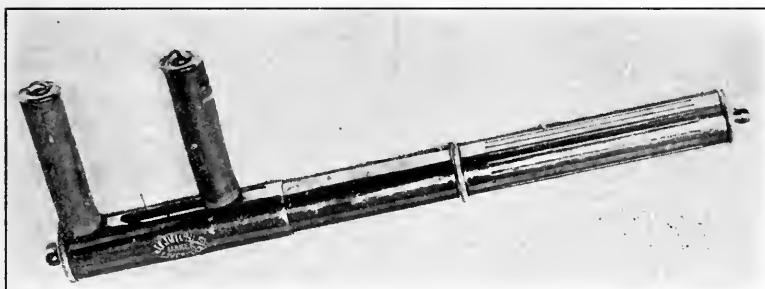


FIG. 187. Illustrates the Thomas wrench used in breaking up adhesions and stretching contractures in and about the ankle.

forcible overextension in plaster of Paris. Long standing contracture of the flexor tendons cannot be overcome by manipulation and in such cases they should be divided. Structural changes in bone, whether inflammatory or due to the long continuance of deformity, will not usually yield to brisement forcé. If they are to be corrected, osteotomy must be employed. In those cases where there is a thickening of the joint capsule on the extensor surface, obstructing motion in that direction, prolonged fixation in an extended position may cause absorption of this redundant tissue; under some circumstances an arthrotomy for its removal is justifiable.

The necessity for following up the active manipulative treatment of these conditions by passive exercises, massage, and other physical

measures has been already emphasized. The results of brisement forcé are likely to be more satisfactory if the joint has been for several weeks previously subjected to massage and mechanotherapy. Plaster of Paris splints best meet the conditions demanding the employment of fixative or corrective apparatus in the treatment of the types of chronic joint disease mentioned in this Section. In the treatment of various articular symptoms in the knee joint it is desirable to prevent flexion of the leg and to give support to an unstable articulation. For this purpose a caliper splint will be found very serviceable. In measuring for it the distance from a point about two and one-half inches below the adductor attachment to the sole of the foot, in line with the internal malleolus, is taken, the circumference of the thigh at the top of the inner upright, and a tracing of both the outer and inner borders of the leg and thigh are also taken. These measurements, together with the shoe for the side upon which the splint is to be worn, are sent to the instrument maker. The splint is made of two uprights of round, untempered steel of a diameter of about three-eighths of an inch. The two lower ends are bent at right angles to the uprights and fit into a socket in the shoe. At the top the uprights are joined by a flat band of steel attached to the inner upright at an angle of 55 degrees. The outside upright is therefore longer than the inside one. A strap at the bottom encircles the ankle and prevents the uprights from slipping out of the socket. A strap at the top encircles the thigh and a knee cap over the patella prevents flexion of the knee. Such a splint is most used as a protection in convalescence. Manipulative procedures are most successfully practised in the chronic arthritides of the knee and shoulder joints. In the hip, elbow, and wrist, they are much less successful when undertaken to secure greater mobility. Even for the purpose of correcting deformity more persistent after-treatment is required in these than in any other joints. Open operations are performed upon these articulations for the removal of villi, accumulations of fluid and fibrinous clot, bony spurs, and for the correction of deformity by osteotomy or excision.

In the ankle joint where simple manipulative measures are to be employed for the correction of flexion, abduction, or adduction of the foot, the Thomas wrench will be found of great service.

### ANKLE

Open operation is required about the ankle for the relief of several conditions, only a few of which need description. The infectious spurs and bursæ about the foot demand removal in some cases. The bursa anterior to the lower end of the Tendo Achillis is most easily reached and may be thoroughly removed through two lateral incisions of about two inches in length, one on either side of the Tendo Achillis beginning at a point opposite its insertion into the os calcis upward. A spur will very frequently be found projecting from the os calcis directly into the bursa. The bursa is often thick-walled, contains a very small amount of thick, viscid, though clear, straw-colored fluid, and the lining of the bursa is very villous, sometimes almost gelatinous in appearance. The spur consists in part of a soft, irregularly deposited cartilage which extends across the breadth of the posterior superior portion of the os calcis. The attachment of the Tendo Achillis need not be disturbed in the removal of such spurs or bursæ. Two weeks is generally a sufficient time to keep off the feet after this operation. Care should be observed in the after-treatment in order that pressure from the counter of the shoe may not keep up an irritation at the site of the bursa. A spur on the plantar surface of the foot is best reached through an incision at the juncture of the skin of the side of the foot with the thicker skin of the sole, at a point opposite the insertion of the plantar fascia into the neck of the os calcis. There is so much fat on the plantar surface of the foot, and during the formation of these spurs there is so much local vascularity, that it is better to perform this operation with a tourniquet, otherwise it has to be done largely by the sense of feeling. This spur is very closely related to the plantar fascia and extends well across the neck of the os calcis, so that care has to be exercised to remove it all. In appearance the spur is much

like that described in the case of the Tendo Achillis. There is less likely to be a bursa in this situation. Convalescence requires about two weeks in bed, and felt pads or flat foot plates designed to relieve the pressure upon the neck of the os calcis will make walking easier.

The ankle and tarsal joints are very difficult to approach for the purpose of getting out villous, capsular thickenings. Long, semi-lunar incisions on either side of the joint parallel with the course of the posterior tibial and peroneal tendons will most efficiently expose the joints between the tibia and astragalus (Figure 115, page 250), the astragalus and os calcis, and the astragalus and scaphoid. It is occasionally permissible for this purpose to divide the peroneal tendons and sever the outer ligaments of the ankle in order to dislocate the tarsus upon the tibia for the purpose of making a more thorough dissection of the synovial membrane of the ankle joint. The sheaths of the tendons on the outer and inner sides of the ankle are frequently affected by villous or fatty thickenings. These sheaths may be opened by short incisions, the growths dissected out with scissors, and the sheath closed with catgut. Plaster dressings to the foot and leg should be worn after such procedures for three or four weeks. If it becomes necessary to dislocate the ankle, the peroneal tendons would require suturing and longer fixation in plaster would of course be required, — probably at least six weeks.

Correction of osseous deformity at the ankle joint, when it consists of plantar-flexion of the foot, which is incorrigible by manipulative measures, requires a supra-malleolar or Trendelenburg (Figure 3) osteotomy or a wedge-shaped resection of the neck of the astragalus. The first of these is performed subcutaneously upon the anterior surface of the tibia about one-half to three-quarters of an inch above its articulation with the astragalus, both tibia and fibula being divided through the same incision. An open operation will be necessary for an osteotomy of the neck of the astragalus. In either of these procedures plaster fixation will be required for from eight to ten weeks.

*KNEE*

Surgery of the knee joint in the chronic arthritic processes may be undertaken for the removal of fringes, osteophytes, inspissated fibrinous clots, purulent or serous exudates, and the correction of deformity.

When the removal of infectious or atrophic fringes becomes a surgical necessity, they are best reached through two parallel, lateral incisions. These should be about four inches in length and should extend from just below the line of the articulation (Figure 4), upward and should be located about halfway between the side of the patella and the most prominent part of the external and internal femoral condyles respectively. This permits exploration of the quadriceps bursa and the infra-patellar region of the joint. During some part of the operation the leg should be flexed and the patellar tendon retracted from the front of the joint in order to give opportunity for as thorough an inspection of the trochlear surfaces of the femur, tibia, and patella as may be. A more thorough inspection can be made and a more complete dissection of the synovial membrane will be possible if the patellar tendon is divided or the patella itself is sawn through transversely and turned back, the leg being flexed to its full extent. Such radical measures are not to be advocated except in those cases where subsequent ankylosis is hoped for or expected, or in case of grave sepsis following infectious processes. Villi and lipomata may be dissected away from the synovial membrane with the scissors to almost any extent, as the serous membrane has great capacity for reproduction. After the purposes of the operation have been accomplished the joint may be washed out with sterile salt solution and the capsule closed with interrupted sutures of silk or catgut. These sutures need not be placed very close to each other. The skin should then be closed either with buried or interrupted silkworm gut. In most cases where such operations are undertaken for the removal of non-inflammatory fringes or lipomata, no drainage is necessary. If there has been much hæmorrhage or the operation has been a long one and it

has been necessary to insert the examining finger, instruments, or sponges, a great many times it is better to leave temporary drainage for from twenty-four to forty-eight hours. Fixation in plaster, unless there has been some deformity which it is desired to overcome or unless ankylosis is to be encouraged, is not necessary. In suppurative cases the posterior wire splint is the most convenient fixative dressing. It is rarely necessary to tie any bleeding vessels on the surface of the synovial membrane. Occasionally some of the anastomotic vessels in the skin may require a ligature. When very vascular, friable fringes are encountered it is sometimes desirable to operate with a tourniquet applied. Early manipulation in all cases where motion is expected is essential to success.

An arthrotomy of the knee joint should never be undertaken without a thorough appreciation of the dangers from infection. The most scrupulous asepsis must be maintained and even then there may be an occasional unfavorable result.

Excision of the knee joint for correction of deformity is performed in the same manner that it is for removal of disease. (Vide Section I, Chapter VIII, page 245.) It will be found to be a much more difficult undertaking however. When done for this purpose it is necessary to take from either side of the joint only so much of the bone as will permit of the correction of deformity. This may be accomplished by removing only a thin section of the cartilage from the femur and tibia. The patella is frequently firmly adherent in these cases and it is necessary to pry it off and oftentimes to completely remove it. Where it is possible in such cases to save it, it may be desirable to do so, as it can be used to good advantage in helping to ankylose the joint after removal of the cartilage on its inferior surface. The best incision for this purpose is a U-shaped one with the closed end of the U pointing toward the foot and its lowest point just a little above the tibial tubercle. Metal sutures or nails through the bone are not required after an excision, though they are sometimes employed; neither are the dovetailing bone incisions or the subperiosteal operations of especial advantage. It is better to leave the leg flexed about five degrees after an

excision. Drainage should be inserted in the two angles of the incision for forty-eight hours. A posterior wire splint until the stitches are removed, to be followed by plaster of Paris for ten to twelve weeks, covers the post-operative treatment of an excision as a rule. The patient can generally begin to bear weight on the excised knee at the end of that time.

For the correction of extreme degrees of flexion of the knee with ankylosis it is sometimes possible to resect a wedge from the anterior surface of the fused bones, which shall include a portion of the femur, a portion of the tibia, and all of the patella. The base of the wedge may be as much as two inches in breadth and its apex, which will be somewhere near the posterior cortical shell of the joint at this level, will be about half an inch or less in breadth. This leaves a thin, posterior, cortical shell after removal of the wedge. This is easily fractured manually and the approximation of the anterior surfaces of tibia and femur enables flexion to be overcome if the base of the wedge is broad enough. This procedure leaves a "dead space" in the centre of the bone which necessitates a little longer time for firm union to be established but does not shorten the limb. Another caution must be observed in doing this operation, and that is, forcible extension should be carried far enough to satisfy the operator that the base of the wedge is sufficiently broad to permit of complete extension; the leg must then be left only partially extended in order to avoid a rupture of the popliteal vessels. This has occurred in connection with this operation and gangrene of the leg resulted. After a week the extension may be completed without risk. This operation is used in the correction of deformities of such an extreme degree that Macewen's osteotomy could not be employed.

### *HIP*

In the management of the acute and chronic stages of the three types of joint disease at the hip joint discussed in this Section very little operative surgery is required. This articulation is difficult to

get at for purposes of drainage. (Vide Section 1, Chapter VIII.) The capsule fits the joint very closely and the capacity of the contained space is small. Manipulative measures are very unsatisfactory, whether instituted to secure motion or correct deformity. Ankylosis in a slightly flexed position with a few degrees of abduction, if there is any actual shortening, gives a very serviceable limb. Albee has devised an operation for anchylosing this joint by removing a protion of the superior lip of the acetabulum and the upper portion of the articulating head of the femur.

Incision and removal of infectious fringes is rarely indicated at the hip joint because it is not likely that function will be at all improved thereby.

Exploration of the hip joint is best accomplished through an anterior incision. Excision is most easily brought about through the lateral or posterior incisions of Kocher and Langenbeck. An incision into this articulation for any purpose whatever should be drained, at least temporarily. Osteophytes on the head of the femur and spurs on the superior lip of the acetabulum which project over the head of the femur in such a manner as to interfere with motion may occasionally require removal.

Operations for the correction of deformity at the hip consist of osteotomies either trans- or subtrochanteric. The one most commonly employed is that known as Gant's osteotomy. It is readily performed subcutaneously with an osteotome. (Vide Section 1, Chapter VIII.) The point of the instrument is driven through the skin over the outer side of the thigh at a point just below the greater trochanter. The skin incision is made parallel to the long axis of the femur; when the periosteum is reached the chisel is turned at right angles to the skin incision and the femur is incised across its entire width and as deep as the cortex of the inner aspect of the bone. The chisel should then be removed and the fracture completed with the hands. It is desirable not to make a complete fracture of this last portion of the femur but rather to splinter it. The deformity is then corrected and the thigh, leg, and foot, together with the trunk, are encased in plaster of Paris, applied with the



limb in a corrected position. Because of the difficulty of judging the amount of correction beneath a plaster when the patient is on a "spica board," it is usually wise to remove the first dressing at the end of three weeks and reapply the plaster. About twelve weeks is required for firm union of such a fracture and it is desirable to postpone such an operation until growth has nearly ceased. In some cases an oblique osteotomy is more desirable than a Gant. Patients will usually be able to get up and about on crutches in from three to six weeks after an operation of this kind.

The mechanical treatment of lesions of the hip joint is generally managed with plaster of Paris or leather spicas. The hypertrophic is the type of chronic joint disease most frequently treated in this way.

### SPINE

In the spinal forms of chronic joint disease no operative procedures are practised, except that it is justifiable to attempt to limber up rigid spines in which the respiratory excursion is becoming restricted. Baer reports the removal of spurs from the vertebral bodies in cases of this sort. If this restriction is permitted to continue serious pulmonary disease may supervene. Anæsthetization and hyperextension of the dorsal spine increases the amount of expansion of the chest. This should be followed up with general exercises and especially pulmonary gymnastics. The type of arthritis causing this symptom is generally an infectious one. In hypertrophic spinal lesions the plaster and leather jacket is most commonly employed for disease in the dorsal and lumbar regions. In the cervical region a Thomas collar will afford the desired relief as a rule. In hypertrophic and infectious lesions of the sacroiliac joints a plaster spica should be applied in the acute stages to be followed by webbing belts, elastic trunks, or other forms of convalescent apparatus.

*UPPER EXTREMITY*

The three types of chronic joint disease are rarely treated in an operative or even a mechanical way in the upper extremity. Infectious lesions of the sub-acromial bursa and the shoulder joint itself are occasionally subjected to forceful manipulation. Arthrotomy and excision are rarely indicated in the shoulder joint. At the elbow joint brisement forcé is rarely beneficial for the purpose of securing motion. The joint is too complicated to permit of motion being easily secured. If right-angled ankylosis in the infectious cases can be established a very satisfactory functional result may be obtained. In case this cannot be attained an excision should be advised. This is best accomplished by a straight posterior incision over the olecranon. Care in the avoidance of the ulnar nerve is the main caution to be observed. (Vide "Excision of Elbow," Section 1, Chapter VIII, page 247.)

In some cases spurs form in such situations upon the olecranon and the coronoid processes that their removal is feasible. If motion is obviously mechanically blocked by such spurs and if the part of the arc of motion so restricted is an essential one for function, surgical interference for this purpose is justifiable, especially in the type of hypertrophic disease occurring in young adult life as the result of trauma.

The elbow joint has been opened by the authors through lateral incisions for this purpose on several occasions. Judicious and persistent after-treatment will secure motion, even after quite an extensive operation of this kind, provided it is aseptically performed.

Plaster, leather, and celluloid splints represent the principal materials from which apparatus for the elbow joint is constructed.

In the wrist joints the atrophic and infectious forms of joint disease are the only ones which give rise to symptoms demanding surgical treatment. These cause deformities which have to be manipulated, but such manipulation does not secure much, if any, improvement in function and it is sometimes difficult to preserve

the correction of deformity which has been accomplished. Excision of the wrist is never undertaken for these conditions, though it might well be done in some cases. Plaster, leather, and celluloid splints are most commonly employed to fix the wrist joint.

Many of the deformities in this region are dependent upon the posture maintained during the acute stage of the disease and are the result of contractures of tendons and capsule. By gradual stretching, such contractures may be overcome and a permanent cure effected when no cartilaginous erosions have occurred. For the accomplishment of this a wire splint with compartments for each of the fingers is very useful. It can be bent as improvement takes place.



## SECTION III

### CHAPTER I

#### LUES OF THE BONES AND JOINTS

At present we possess very little knowledge of syphilitic bone disease, though with certain lesions we are more or less familiar because of their common occurrence. New forms of luetic bone affection are found not infrequently and probably will continue to be encountered unless the pathologists discover some histological change of its lesions which is characteristic of lues alone and is reproduced in all forms of syphilitic lesions.

Any attempt at a classification of this type of bone affection is sure to prove as incomplete as our present knowledge, but the disease is so common that for purposes of study its separation into several types seems wise.

The element of **pain** in luetic disease varies from an acuteness like that of severe osteomyelitis, as, for example, in certain tertiary lesions with few external signs, to an almost entire absence of sensation, as in the greatly disorganized joints accompanying some cases of tabes dorsalis. In the hereditary forms it is usually of moderate severity and accompanied by tenderness at the seat of lesion.

#### BONE LESIONS

The bone lesions of lues occur most commonly in the hereditary form and tertiary stage of acquired disease. In the secondary stage bone lesions are rare. Acutely sensitive small areas of periostitis, often multiple, may be found late in this stage, but in our experience are of infrequent occurrence.

Hereditary syphilitic disease manifests itself usually early in life and has associated with it not rarely lesions of the bone shafts,

and sometimes of the joints. These hereditary lesions are divided into the early and late forms.

The early form occurs soon after birth and resembles rickets.



FIG. 188. Note the enlargement of the diaphysis on the left and the rarefaction about the epiphyseal line.

Gelatinous masses are formed beneath the periosteum and at the epiphyseal line with sometimes true fracture of the shaft or separation of the epiphyses. There is said to be thickening of the periosteum and bone cortex.

One of the late hereditary forms deserves a special mention, since it represents a more or less constant clinical picture. This is the so-called juxta epiphyseal type. Here areas of bone necrosis in the diaphysis accompany calcareous deposit beneath the periosteum, and cortical thickening. This overgrowth, the fact that the joint surfaces are as a rule unaffected, and the location of the lesions in the diaphyses differentiate the condition from a diffuse tuberculosis. The absence of high temperature and the comparative mildness of the symptoms, in proportion to the extent of bone involvement, differentiate it from osteomyelitis.

The lesions are often multiple. In our experience the lower femoral and the upper tibial diaphyses (Figure 188) are the favorite seats of the disease and, on account of the swelling of the soft parts, simulate true joint lesions.

In the late hereditary and tertiary forms cortical thickening and calcareous deposits beneath the periosteum are the most characteristic and common manifestations of lues. These give rise



FIG. 189. Note the thickening of the fibula and compare its size with that of the tibia. The local enlargements represent the so-called "bone blisters."

to the typical sabre-shaped tibiæ and the tender, fusiform swellings along the shafts of the long bones which are so well recognized. Frequently small areas of rarefaction with a rounding cap of dense bone raised above the line of the normal shaft are seen in the skia-

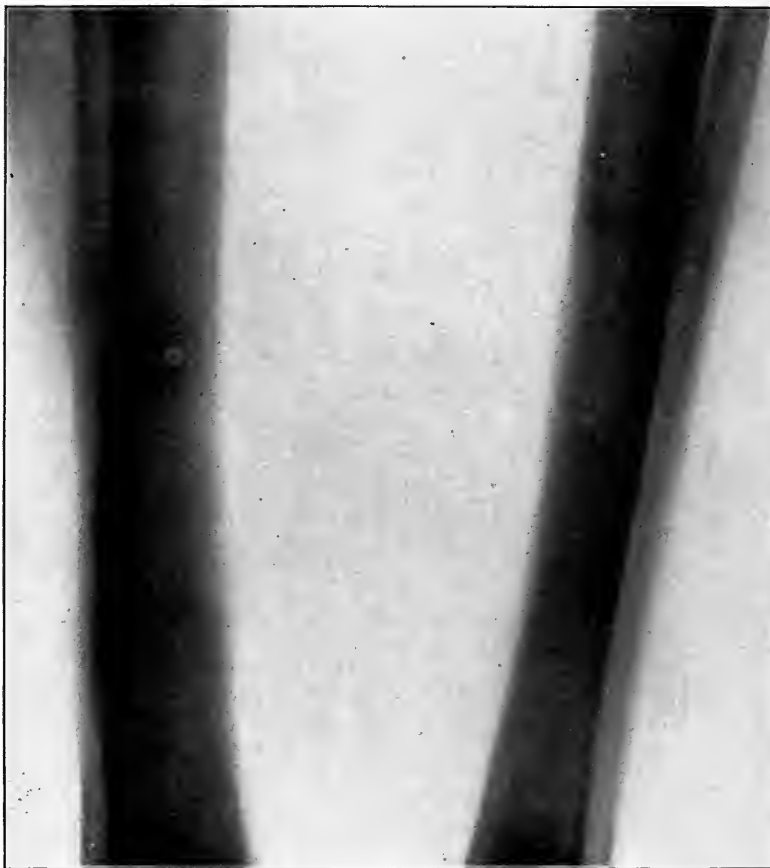


FIG. 190. Observe the thickening of the right tibia due to a general periosteal and cortical enlargement. Compare it with the left tibia not so affected.

graphs. These have been well named by Codman "bone blisters." (Figure 189.)

The calcareous deposit beneath the periosteum, often considered in the skiagraph to represent evidence of periostitis, appears here as a faint bulging along the shaft, looking not unlike early callous.



The only conditions likely to be confused with this lesion are an early osteomyelitis proper or that form known as osteomyelitis



FIG. 191. Observe the eaten out condition of the left side of the first and second lumbar vertebræ. This differs markedly from the appearance in Pott's Disease when the bones would have collapsed and been fused together much more than here. This patient's hands are shown in Figure 192.

serosa or periostitis alba or certain atypical cases of giant-celled and periosteal sarcoma.

The cortical thickening is usually more marked along one side of the bone, often encroaching upon the medullary cavity (Figure 190), and has led to confusion of the lesions with those of Paget's Disease, or Osteitis Deformans.

**Bone gummata** in the tertiary stage are both superficial and deep, the former occurring between the bone and periosteum causing ulcerations of the cortex. These gummata may be neighboring



FIG. 192. Note the sharply punched out hole in the second phalanx of the left middle finger and the enlargements of the second phalanx of the right thumb and the second metacarpal of the right hand, all of which are characteristic of syphilis. This patient's spine is shown in Figure 191.

and join each other in a stellate manner. The deep gummata occur in any part of the bone and may lead to fracture. Great eburnation may take place in the bone thrown out in the cortex next the lesion.

It suffices here to remind the reader of the diffuse syphilitic osteomyelitis mentioned in the Section on Osteomyelitis, page 474.

Syphilis may produce vertebral lesions, as is shown in Figure 191, a patient who was treated as a case of Pott's Disease until the

development of a dactylitis (Figure 192) suggested the possibility of a syphilitic infection and the results of anti-syphilitic treatment confirmed this opinion.

### JOINT LESIONS

Of the joint lesions which occur as a result of luetic infection we find great differences of opinion. That they have been too rarely recognized is beyond question.

There is scarcely a subject in medicine upon which one ventures an opinion about which he can be less dogmatic than upon the subject of syphilitic arthritis. Among clinicians and pathologists syphilis has been the cloak under which diagnostic incapacity has hidden itself. Because of the difficulties in diagnosis by the usual and proper methods of physical examination the therapeutic test has been relied upon to clear up clinical difficulties. In some of the chronic rheumatic diseases the therapeutic test is frequently applied. As our knowledge of these subjects increases, the utility of this test in these diseases is being shown to be of practically no value. Doubtless as our knowledge of the clinical and pathological evidences of syphilis in the joints becomes better established, the recognition of this disease as a causative factor in arthritis will be made apparent by history taking and physical examination, as has been the case in the chronic polyarticular diseases to which reference has been made.

That syphilis plays an important rôle in causing arthritic symptoms there is abundant proof on the clinical side. Pathology has naturally not much proof to offer. Richet in 1853 called attention to the occurrence of syphilitic synovitis in children, and since then Virchow, Lancereaux, Voisin, Clutton, Bowlby, Howard Marsh, the Hutchinsons, Sr. and Jr., and many others have contributed to our knowledge of the subject. Von Hippel found that 56% of his cases of hereditary syphilis showed joint lesions of a character which he believed to be specific. Fournier found nearly 40% in 212 cases. The latest edition of Kaufmann's "Special Pathology" however declares luetic joint lesions to be rare, though he states

that they are commoner in the hereditary type than in any other. They take the form of an exudative arthritis caused by a neighboring gumma or an osteochondritis which breaks through the epiphysis into the joint.

Kirmisson and Jacobson in 1899 classified the hereditary forms of syphilitic joint disease as follows:—

(1) A single osteoarthropathy, commonest in the large joints, beginning insidiously with severe and persistent nocturnal bone pain. One of the bony extremities enlarges and the condition simulates tumor albus. There may be hyperostoses at some distance from the joint. The limitation of motion is mechanical only.

(2) Hydrops may be the important feature. The synovia is thickened locally or diffusely. Bony changes are not evident on examination.

(3) A third form may be spoken of as a deforming osteoarthropathy in which an epiphysis may become irregularly and greatly changed in shape with resulting marked limitation in mobility.

There seem to be two types of articular gumma. One is perisynovial or capsular, spreading into the articulation and producing villi which may contain minute gummata. This form may extend to the capsule and produce destructive changes in the cartilage and bone. (Figures 192 and 193.) Case II, page 453.

There is also the primary osteal form extending into the joint, producing extremely destructive changes in the bone and cartilage, and in some cases resulting in suppuration and ankylosis.

Before leaving the subject of hereditary luetic joint lesions, we should consider briefly the type spoken of as Lues Hereditaria Tarda.

The form developing in children who early in life have shown unmistakable signs of syphilis, which has disappeared under energetic treatment, but which manifests itself later in bone and joint lesions, is well recognized. Whether there is a form of joint lesion due to an inherited syphilitic taint which develops either late in childhood or even early adult life, but where there have been absolutely no recognized earlier signs, is still in dispute. There is much to indicate

that such forms do occur, and their great clinical importance is at once evident. If these forms do exist they might easily be confused



FIG. 193. Note the destruction of the patella and the capsular thickening over it indicative of a gummatous change in both the patella and the capsule.

with tuberculous or “rheumatic” lesions, the treatment of which along these lines would be obviously unproductive of satisfactory results.

Jordan <sup>1</sup> reports several cases which he is convinced belong to this type and which seem to bear out his contention, both from the history and their response to anti-syphilitic treatment.

In adults Kaufmann <sup>2</sup> states that even in the primary stage there may appear an acute febrile arthritis with serous effusion, apparently most common in the sterno-clavicular joint. Certainly the

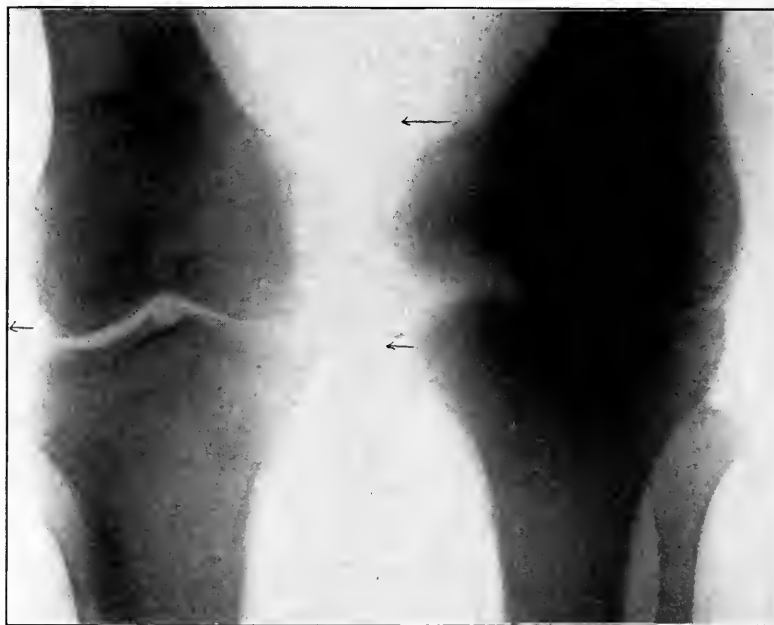


FIG. 194. Compare the left internal condyle with the corresponding one on the right. This condition was shown at operation to be a gumma. The arrows should point in the opposite direction in each case.

usual manifestations occur during the secondary and especially the tertiary stages.

They are difficult to classify, but for clinical purposes may be grouped by stages of the disease, having been thus separated by H. Morestin.<sup>3</sup>

(a) Simple arthralgia without objective symptoms but accompanied by severe pain often sharply localized over tendons and

<sup>1</sup> Jordan, *Münchener Med. Wochenschr.*, Aug. 4, 1903. <sup>2</sup> *Spec. Path.*, p. 700.

<sup>3</sup> H. Morestin, *Arch. gen. de Medicine*, vol. 5, p. 101, 1903.

ligaments. This is almost invariably worse at night. The larger articulations are most commonly affected. They are coincident with secondary lesions and yield rapidly to mercurial administrations.

(b) A form of subacute arthritis. This is rare, and has been spoken of as "syphilitic rheumatism." It occurs early in the secondary stage and is characterized by slight effusion and swelling with white or only slightly reddened joints. They may simulate gonorrhœal lesions.

(c) Hydrops may be the only clinical symptom. This form is the commonest of the early arthropathies and may occur in the beginning of the secondary stage or as late as a year or more after infection. The course is slow and insidious, without discoverable membranous or bony changes. The knee joints are most frequently affected.

#### LATER LESIONS

The later lesions resemble those of the hereditary form and correspond in the main to the "syphilitic white swelling" of Richet (1853).

They may be grouped under two heads.

(a) Those in which the synovial lesions predominate are most common in the knee and are usually monarticular. There is marked effusion, a gradual onset, and often sharp pain. On examination, rounded or flattened firm bodies are discovered located at the points of ligamentous attachment. They are somewhat moveable and resemble foreign bodies. These are gummata, and may go on to ulceration and open into the joint. The bony ends are usually intact or show only slight hyperostosis. Motion is nearly normal. There is considerable muscular atrophy.

(b) Those in which bony changes are most marked. Here we find marked hyperostosis. The end of the bone becomes enlarged, smooth, and rounded. The development may be rapid. Pain, if present, is worse at night. This type, the least amenable to treatment of all types, is usually associated with severe manifestations

of the disease. It may result in ankylosis or great relaxation and hypermobility. If secondary infection occurs and sinuses form, the periosteum may react and produce new bone with cavities.

Generally stated, serous and sero-fibrinous arthritis may occur in the early stages of syphilis, whereas gummatous infiltration is more characteristic of the later course of the disease. The terminal forms are more chronic in nature. Fournier and Virchow have described a deforming type which resembles the lesions of "arthritis deformans." This must be rare, we believe, in this country.

There is as yet no definite evidence to prove that syphilitic joint lesions occur in the presence of a previously existing tubercular infection, though this occurrence has been reported.

#### DIAGNOSIS

In the diagnosis of luetic bone and joint disease the history of hereditary taint and of venereal lesion or secondary manifestations of the disease are obviously most significantly important. Many of the types will be readily recognized after clinical experience, but here again we have in the X-ray our most trustworthy aid in diagnosis, if the technique is good and we train ourselves in the interpretation of these radiographs.

In the supposed hereditary luetic lesions one should always inquire carefully into the parental history, the existence of a previous or present keratitis, scars at the corners of the mouth and nose, and should look for other evidences of a syphilitic infection.

No description of syphilitic joint lesions would be complete without mention of arthropathy joints. Whether these should be considered as representing true syphilitic infections or whether we should conceive them to be arthropathies secondary to cord or nerve lesions is questionable. It seems to us that they should more probably be classed as neuropathic lesions, but from a clinical point of view the distinction is perhaps unimportant. These joints are usually found in cases presenting definite symptoms of tabes dorsalis, and in their early manifestations may present difficulty in differ-



entiating from a simple villous arthritis or even tuberculosis. Joint swelling and effusion are present. On section there is frequently a marked villous formation and an excess of fluid of a serous type. The membranes are infected, but there is no abnormality of the cartilaginous joint surfaces. (Case 1, pages 448-52.)

As the condition progresses, the ligamentous structures become greatly relaxed, the joint more and more unstable, and great loss of bone substance occurs, apparently accompanied in some cases by new bone formation. Pain is rarely present in any marked degree. Subluxations occur and tremor is not infrequently noted. Weight-bearing without apparatus becomes difficult if not impossible. On section at this stage, one cuts through gelatinous and fibrous tissue containing much serum. The joint is filled with detritus often containing lime salts and the newly formed bone, if such it be, is soft and spongy. The articular surfaces are largely destroyed and only islands of cartilage remain. The condition may be mono-articular or polyarticular, the knees being most commonly affected.

After a certain stage has been reached the process seems to become in large measure quiescent. The local signs and symptoms cannot be readily distinguished from the joint lesions of seringomyelia.

#### TREATMENT

We must rely upon the administration of antiluetic drugs, notably Potassium Iodide and Mercury, in our treatment of syphilitic bone and joint affections as in other manifestations of the disease. The response is usually rapid and extremely satisfactory to both patient and physician. We are inclined to believe that in many cases the doses of Potassium Iodide may be increased to very large amounts without intolerance or evidences of intoxication, and that some of the more obstinate symptoms yield to these large doses alone. It should also be borne in mind that the hereditary lesions require more energetic and prolonged anti-syphilitic medication, and yield less readily and completely to this treatment than those occurring in the acquired form.

Operative surgery apparently must in these conditions play a minor part. Broken-down gummata should, of course, be drained. Certain observers believe that obstinate lesions yield more readily to anti-luetic treatment if section of them is made. Protective apparatus is often of great service in the tabetic joints and the stability thus secured enables the patient to regain comfortable locomotion. The type which has been found most useful in the knee is the double upright brace, fastened to a foot-plate. The brace extends from the sole of the boot to the groin, jointed at the ankle and knee and firmly fastened to stiff and accurately fitted leather thigh and calf cuffs, laced in front. Accessory padded pellotes may be fastened to the uprights to give the desired stability by pressure at appropriate places.

#### PROGNOSIS

The prognosis of syphilitic disease of the bones is good so far as relief of pain and restoration of function is concerned. The lesions may be evident after all symptoms have disappeared and these permanent changes in bone structure may be demonstrated in the radiograph.

The joint affections also are, with the possible exception of the tabetic arthropathies, amenable to anti-luetic treatment, and after a thorough course of such medication manifest few traces of the disease.

**Charcot's Disease. Case I.** (Vide Figures 195, 196, 197, 198, 199.) Male, 38. Patient has always been well, except for syphilis which he contracted at 24 years, and for which he was under a prolonged course of treatment, and was supposedly entirely well. Two months before entering the clinic he undertook to close a heavy door, in doing which he pressed the inner side of his knee against the edge of the door. In doing this he experienced no particular discomfort, but within two or three hours the knee joint commenced to swell, and became very much enlarged and quite painful. His family physician tried conservative treatment but to no purpose, and after

two months of this recommended surgical interference. The right knee joint was very much swollen, both over, above, and below the knee joint. There was some increase in the surface temperature, marked effusion into the joint, and considerable capsular thickening. Tenderness to pressure was not marked. No other joints were involved. When the joint was kept quiet there was not much discomfort except from the feeling of distention.



FIG. 195.

FIG. 196.

FIGS. 195 and 196. These photographs show the external appearance of the right knee in Case I. Taken in this position they imperfectly show the characteristic hypermobility better seen in Figure 200.

Arthrotomy was advised. Incisions were made on either side of the joint and a thin serous fluid escaped in large amount when the capsule was opened. There was extensive villous hypertrophy of the lining membrane of the joint but no change in the cartilage of either femur or tibia so far as could be observed through the two incisions. A provisional suture was left untied, permitting the insertion of a wick at the angle of the wound. Through this opening a profuse discharge of serum took place for over a month after the operation. The wound was not infected. During this convalescent period the patient made complaint of very severe paroxysmal pain

in the abdomen. Two months after the operation patient first noticed abnormal mobility in the knee joint which was not accompanied by pain. The swelling had remained about the same as before the arthrotomy, but no longer seemed to be due to fluid.



FIG. 197. Lateral view taken of Case I early in the course of the joint lesion.

Patient was then tested to determine the condition of his reflexes. There was an Argyle-Robertson pupil and no knee jerk could be obtained. As will be seen in the X-rays the joint underwent considerable disintegration between the time of the taking of the skiagram before operation and those taken after there were clini-

cal evidences of the Charcot's joint. There is now (two years after the operation) a marked degree of lateral motion of the tibia upon the femur and a very considerable amount of genu recurvatum.

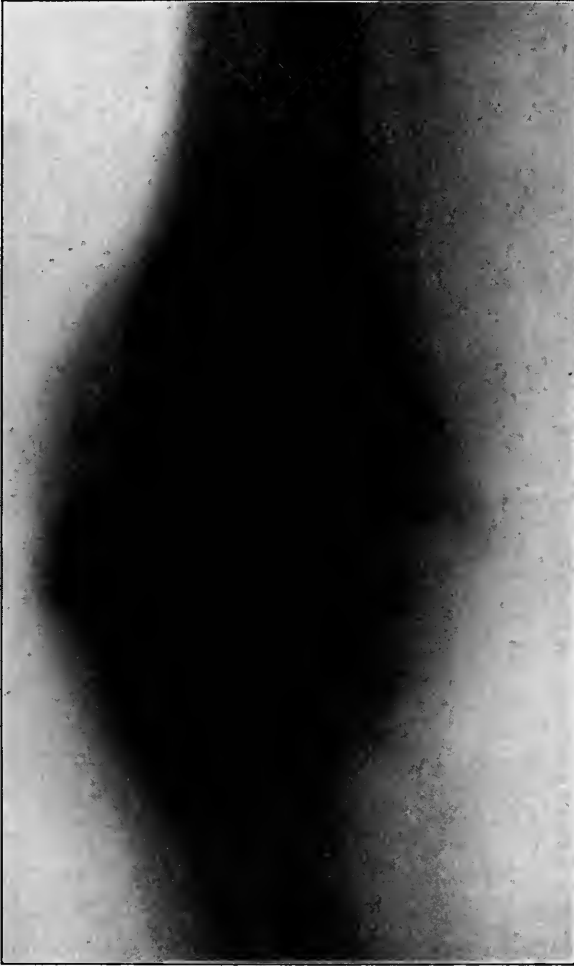


FIG. 198. Antero-posterior view taken of Case I early in the course of the disease. Compare this and Figure 197 with Figure 199, taken after the acute phase of the process had passed.

Patient can walk now quite freely without the use of a splint, and during the past six months the condition has improved. No other joints have become involved. He has been taking the Iodide of

Potassium pretty steadily and wearing a jointed leather leg splint, most of the time.

The report of the pathologist did not indicate any conditions other than those due to chronic inflammatory changes.



FIG. 199. A later view of Case I. Note the destruction of the condyles, the remains of which are to be seen as detritus in the joint.

**Case II.** This patient was a woman of 46 years, who developed a painless lesion in the left knee joint which was diagnosed as tuberculosis, and an excision was recommended before it was realized that the patient had signs of tabes dorsalis. The operation was performed and failure of union resulted. A similar condition developed in the other knee and council was procured. The patient then had evident signs of tabes. The photograph of this case is here shown (Figure 200) because it illustrates better than the photograph accompanying Case I the lateral mobility of these tabetic joints.



FIG. 200. Illustrates the lateral mobility characteristic of the lesions of Charcot's Disease of the knee.

**Syphilis. Case III.** (Vide Figures 193, 194.) Mr. M. 30 years. Gumma of patella.

This patient was first seen because of a swelling in the left knee joint. This had been very gradual in its development and painless. There was no restriction in the motion of the joint except such as might be accounted for by the swelling of the capsule. There was no history of previous arthritis and the patient denied venereal infection. There was no traumatic history. No other joints were involved. Conservative treatment did not seem to yield any result and arthrotomy was advised. The synovial membrane was much hypertrophied; there was moderate effusion into the joint and no change in the surfaces of the cartilage. Histologically there were marked chronic inflammatory lesions. The immediate effect of removing the hypertrophied villi was good and it was some months before the swelling recurred. Nine months after the operation two indolent ulcers appeared just below the patella. These had ragged,

undermined edges. An X-ray taken of the knee joint showed considerable erosion of the patella and thickening of the soft parts below the patella immediately in contact with the ulcerations on the surface of the skin. The patient was immediately put upon large doses of the Iodide of Potash and inunctions of mercurial ointment. In a short time the ulcers appeared cleaner and manifested a tendency to heal, which they did in about a month. The capsular swelling also diminished and the outline of the patella as seen in the X-ray soon became clearer and more well defined. At the end of eight months the joint seemed practically normal and its function was not at all impaired.

A similar case in a woman of 48 years has recently come under the observation of the authors, and has responded equally well to treatment with the Iodide of Potash and the Biniodide of Mercury. Both of these cases were seemingly hereditary and probably represent in their synovial lesions the miliary gummata which are described as occurring in the serous membranes.



## CHAPTER II

### OSTEOMYELITIS

→ ANY inflammation of bone may properly be called an osteomyelitis. According to Nichols <sup>1</sup> "infectious osteomyelitis is an acute suppurative inflammation of the bone and is always due to infection of the bone marrow by pyogenic micro-organisms." There may ensue as sequelæ or even concomitants of this inflammatory process cortical thickening, periostitis, and diffuse or circumscribed suppuration, with cavity formation and the production of sequestra.

The common conception of osteomyelitis as a definite disease with a more or less constant clinical picture is wrong. Sudden onset, high fever, excruciating pain, and general systemic infection surely present a striking picture of one form of this condition, but this is not the most common type nor the only type demanding accurate diagnosis or amenable to rational treatment. Although it is true that the staphylococcus pyogenes aureus is the cause of the great majority of cases of acute infectious osteomyelitis, other bacterial agents may produce as definite and important forms. We are not dealing here with a single bacterium, whose invasion gives us a constant clinical picture varied only by the resistance of the individual, the number of micro-organisms, or the state of their virulence. Rather are we considering a pathologic condition which may be brought about by very different parasites, whose life cycle and toxic products differ greatly.

Osteomyelitis is essentially a disease of the shafts of the bones, rarely affecting the joint surfaces, though often in so close a proximity that the condition may well be mistaken for a joint lesion. Townsend and Whitman <sup>2</sup> have both called attention to the possible joint complications which may arise when the epiphyseal cartilage

<sup>1</sup> *Journal of American Medical Association*, February 7, 1904.

<sup>2</sup> Townsend, *American Journal of Medical Sciences*, January, 1890. Whitman, *Text Book of Orthopædic Surgery*.

fails to perform its usual function of a safe barrier against infection. Those cases in which the streptococcus is the causative agent are most prone to joint involvements. Of the 85 cases reported by these authors, 64 were monarticular and 21 polyarticular.

Keen also, in an article on the surgical complications and sequelæ of typhoid fever, reports that 43% of the cases of typhoidal osteomyelitis involved the hip joint and that in 40% of these there was spontaneous dislocation.

The location of the osteomyelitic process as a rule influences little the train of symptoms accompanying the different types.

#### ETIOLOGY AND PREDISPOSING CAUSES

In discussing the etiology of osteomyelitis we can describe no single cause. Trauma, a neighboring or even distant infection of the soft parts, or some general debilitating or infectious disease produces a *locum minoris resistentiæ*, perhaps a true area of necrosis,<sup>1</sup> and offers the opportunity for the invasion of the micro-organism by means of the blood current. Bones undergoing development seem most prone to infection, and therefore the disease is most common in early life until the adolescent period is passed.

#### PATHOLOGY

Of the pathology of the more common forms of osteomyelitis something more definite may be said. The reader is referred to the excellent article of Dr. E. H. Nichols<sup>2</sup> for a full discussion of the pathology of osteomyelitis.

The bone marrow is the primary seat of the infection, the process usually starting near the epiphysis, but in the diaphysis of the long bones. The multiplication of the organisms produces a soluble toxin, which causes a necrosis of the adjacent marrow cells. The loose structure of the marrow may allow marked extension of

<sup>1</sup> Mallory, F. B., "Ueber die Verbreitung der Osteomyelitis variolosa im Knochen-systeme," *Zeitschrift für Heilkunde*, vol. xv, 1894.

Mallory, F. B., "A Histologic Study of Typhoid Fever," *Journal Exp. Med.*, vol. iii, p. 611, 1898.

<sup>2</sup> *Journal of American Medical Association*, February, 1904, p. 439.

the process before frank suppuration occurs, the dense cortex resisting invasion. Solution of the soft tissue of the marrow takes place, the trabeculæ may break down, and cavities form in the spongy bone. In the early stages no macroscopic changes may be seen, but usually section is made so late that yellowish, greenish, or hæmorrhagic pus, containing fat drops and of a characteristic oily appearance, exudes. The irregular arrangement of the alveolar spaces and bony trabeculæ with this irregular formation of necrotic areas gives a mottled appearance to the bone on section. Fairly early extension to the cortical bone takes place through the Haversian canals and an inflammatory exudate forms between the bone and periosteum, which is often stripped up for a considerable extent. A subperiosteal abscess is thus formed. This abscess may break through all barriers and discharge through the skin, though not rarely fatal toxæmia and septicæmia ensue before this takes place.

Spontaneous fracture or joint suppuration sometimes occurs when the epiphyseal line breaks down. Beneath the stripped-up periosteum there is necrosis of at least the superficial layer of the cortex, while if the inflammation destroys the endosteum the viability of the internal layer and the trabeculæ may be lost. Sequestra are formed where these necrotic areas lie one above the other. An involucrum is formed by the proliferation of the separated periosteum about a necrotic area. A shell of bone is thus built up about the necrotic sequestrum.

The destructive process, as has been stated, is irregular in its extension and the repair process is therefore also irregular, the granulation tissue and endosteal bone being distributed irregularly. Thus the diseased areas may be encapsulated by fibrous or bony formation and be shut off from the sound portion of the shaft.

The regeneration of the cortical bone depends entirely upon the endosteum and periosteum, the bone having apparently little power of repair in itself. If, therefore, both endosteum and periosteum have been destroyed the dense, necrotic sequestrum must either

be spontaneously discharged or removed by operation, leaving a cavity which cannot be expected to close of itself. At times the entire



FIG. 201. This shows the case before operation. A pure culture of the staphylococcus aureus was obtained on culture.

necrotic shaft may be thus encapsulated in an ivory-like case of new formed bone, perforated in many places for the discharge of pus.

All that is known of the pathology of some of the more unusual forms will be considered under their separate headings. We shall



FIG. 202. This is from the case shown in Figure 201, after operation.

consider the various types of osteomyelitis, thereby attempting a general classification for purposes of study.

1. **Acute circumscribed.** Under this heading are included the

so-called bone furuncles (Figures 201, 202, and 203), which are of much more common occurrence than is generally supposed, and are often unrecognized. Rarely does this type spontaneously discharge through the skin. Nichols believes these often start as localized necroses or possibly luetic infections, rather than as primary osteomyelitic foci. They certainly often give rise to comparatively mild



FIG. 203. Note the sharply circumscribed character of the lesion in the tibia.

symptoms, and few external signs other than slight swelling. In children or young adults they occur most commonly in the neighborhood of the joints. We have most often seen the lower ends of the tibia and femur affected. (Figure 203.) The swelling is persistent but variable in degree. The pain is most severe at night, but may not be acute in character. The joint motions are little interfered

with, and a careful examination will show its structures to be only secondarily affected.

In the diagnosis of this condition the X-ray is of greatest help, for its revelations are unquestionable and its simplification of treatment is great. In the radiograph a single focus or multiple foci are shown, appearing as small circumscribed cavities surrounded by dense bone.

**2. Chronic circumscribed.** This type can apparently develop from the acute circumscribed and is not seldom seen after the patient has been treated more or less unsuccessfully for years for one of the joint conditions which its symptoms might suggest. Here the cavities are usually larger and frequently contain sequestra. Their walls are denser

and represent increasingly difficult barriers for the imprisoned pus. The history of



FIG. 204. Note the density of the tibia and its general enlargement. The medullary cavity is obscured by the density of the cortex. Observe the structure of the unaffected fibula. This is from Case III.

measures calculated to overcome a rheumatic process, and with a history not characteristic of tubercular disease, should always suggest a careful skiagraph in which detail of bone structure is shown. Often this will reveal a cavity containing a sequestrum and surrounded by dense new formed bone. (Figure 204.) The acute attacks occur when more or less attenuated organisms are stimulated to activity. The tension of the pus increases, but the walls are too resistant for spontaneous drainage and the symptoms above mentioned ensue.

In both the acute and chronic circumscribed types pure cultures of the staphylococcus pyogenes aureus or albus have in our experience always been obtained at operation.

3. **Acute diffuse.** The acute diffuse type is familiar from the descriptions in all the text-books, and its symptoms are so striking that its diagnosis would not seem difficult.

The onset is often sudden, is associated in the patient's mind with some trauma, exposure, or previously existing disease. The fever is commonly high and prostration soon becomes marked. The pain is severe, localized or radiating. It must not be forgotten however that the onset of this type may be much milder than the usual descriptions would lead one to believe.

The process may be confined to one bone or involve the whole shaft (Figure 205), or multiple foci in the different bones may develop. If untreated, the superficially inflamed skin breaks and sinuses occur, establishing a drainage which is in most cases inadequate. Death may result from general septicæmia. Prompt treatment usually results in recovery.

Both staphylococci and streptococci are apparently able to produce an acute diffuse osteomyelitis, the staphylococci being usually responsible when the process comes on in robust health. The streptococci are commonly found when there has been some recent weakening process, as for example infectious disease, or where there have been wounds or ulcerations of long standing. Streptococcic infections more frequently involve the joints.



This acute diffuse type is one upon which much pathological work has been done, and presents conditions calling for most



FIG. 205. This was a diffuse osteomyelitis of the femur. Note the formation of the involucrum.

timely and often radical treatment, the details of which will be later discussed. From this type result the obstinate sinuses, trouble-

some sequestra, and subsequent deformities of the bony framework and external contour.

Loss of bone substance and subsequent irregular repair, especially in the neighborhood of joints, lead to disturbance of function, to malformations of growth if the disease occur during the growing period and in later life, especially in the lower limbs or pelvis, to static errors demanding operative correction. If the disease affects the epiphysis we may have here the same temporary overstimulation of the growing centre as in tuberculosis. (Cf. illustrative Case I.)

Unhealthy and often exuberant granulations sometimes form about the persistent sinuses and true epitheliomatous neoplasms occur. These may invade the deeper structures, form metastases in the bone, and demand amputation.

**Case I.** M. F., a girl six years of age, was seen on the eighth of April, 1900. The history was as follows:

Having previously been a strong, well child, in January, 1901, she had an attack of diphtheria from which she made a normal recovery. Several weeks later, in the latter part of February, the child developed measles, and ten days after this severe pain, followed by swelling, began in the left lower leg. The swelling, which was chiefly over the upper half of the left tibia, rapidly became fluctuant, and was opened freely soon afterwards, showing the whole upper half of the tibia denuded of periosteum. At about this time, or within a few days from the beginning of the pain in the leg, a pericarditis developed which lasted for a few days. During all of this period the child had a high, irregular temperature, and was very sick. The abscess continued to discharge, and gradually the knee became swollen and painful. This was followed by flexion of the joint, which was corrected under ether three days previous to the time of the first examination.

At that time the left knee was considerably swollen, but not reddened or especially tender to palpation. From the "feel" of the joint together with the fact that the temperature, which had been

high, had gradually come down to nearly normal, the swelling was considered to be serous and not purulent. Below the tubercle of the tibia there was a granulating wound two or three inches long



FIG. 206.

FIG. 207.

FIGS. 206 and 207. These views, taken at an interval of one year, represent an acute diffuse osteomyelitis following measles. Note the sequestrum formation.

with exposed bone throughout the entire extent. It was evident from the appearance of the exposed bone that it was dead, and that it would either separate itself and be thrown off, or would have to be removed at operation. Because of the child's poor general con-

dition and because the new periosteal bone had formed so little in the short period of time since the onset of the trouble, it was considered best to immobilize the leg in a splint and do nothing to the wound other than to continue with antiseptic dressings.

The child's general condition gradually improved, and the last of May she was brought to the office, at which time the first radiograph was taken. (Figure 206.) This showed an extensive osteomyelitic process with the whole upper half of the shaft of the tibia a sequestrum. The attempt at repair with extensive formation of new bone is quite clearly shown, as is also the fact that the disease has extended across the epiphyseal line.

During the summer the splint was continued, with such medicines as would tend to improve the child's general health. In that time two large sequestra have been thrown off with several smaller fragments.

Two other radiographs (Figure 207) were taken, the last on November 8, 1900. This showed almost complete replacement of the shaft of the tibia with a sequestrum between two and three inches long lying somewhat obliquely in the upper part of the bone. The destruction of the epiphyseal cartilage and the extension of the disease into the epiphysis is very clearly shown.

The swelling of the knee joint disappeared and there was about 20° of motion. The left leg was about one-half inch shorter than the right and the wound closed except a small sinus.

In the ultimate prognosis in such a case the most serious feature is, of course, the question of growth, as a very considerable portion of the growth of the tibia takes place from the upper epiphyseal cartilage. Its destruction necessarily means an imperfect development of the leg chiefly with regard to its length. The function of the knee joint, while it will be impaired, will not probably be a very serious limitation, and the strength of the leg, aside from the shortening, should not be much below normal.

The sequestrum was allowed to remain until the irritation of the epiphysis caused a growth of bone sufficient to more than compensate for the initial shortening and it was then removed. The

leg has now in 1908 practically normal motion and function is not at all impaired. The diseased leg is slightly longer than the other.

**Case II.** J. G., a male twenty-three years of age, came to the Hospital on January 20, 1902, with the following history: Family history, negative; personal history, that of a perfectly well man up to the present illness.

Five months before entrance, while riding in a street-car, he turned his head suddenly to look out of the car window and was seized with a severe pain in the neck. Since that time the motions of the head upon the neck have gradually become less free, and have been attended by a more or less constant but steadily increasing amount of pain. Two weeks later he noticed a swelling on the back of the neck, which has increased in size, and he complains at times of chills and fever.

Physical examination showed a well developed and nourished man, somewhat pale, with flushed cheeks and a distinctly septic facies. The head was held rigidly to one side, with the chin depressed and pointing somewhat toward the right shoulder. Over the occipito-axoid region, somewhat to the right of the median line, was a thick, brawny, indurated swelling, non-fluctuant and distinctly tender to pressure.

The patient could not turn his head in either direction, and could open his mouth only with difficulty. The motions of the cervical spine were restricted in all directions, but the restriction seemed more the result of mechanical interference, due to the swelling itself, than upon spasm of the cervical muscles.

Examination of the throat showed no retropharyngeal or peritonsillar abscess. His temperature was  $100.4^{\circ}$  and pulse 100.

An X-ray showed the shadow of an abscess, and a thickening and fusion of the bodies of the second and third cervical vertebræ. Three days later he was admitted to the wards with a temperature of  $103^{\circ}$  and a pulse of 100.

On January 24 an incision was made just to the right of the

median line, opposite the second and third cervical vertebræ, and several drachms of thick creamy pus were evacuated, which on bacteriological examination showed the presence of the staphylococcus pyogenes aureus in pure culture.

A sharp fall in the temperature was at once noted, and in a few days the motion of the neck became freer, and pain was much relieved.

The temperature remained between 99° and 100° for about ten days, when on removal of the drainage tube the abscess reformed and the temperature again rose to 103. At this time a second operation was performed. The original opening was enlarged and an incision three inches long was made to the left of the median line with dissection down to the spinal column; considerable pus was evacuated and drainage tubes were placed in each opening. The temperature again fell to normal, and further convalescence was uneventful. Both wounds were allowed to granulate from the bottom, and at the present writing, one year after the operation, they are completely healed, all motions of the cervical spine are quite within normal limits, and there are no subjective symptoms.

**Case III.** C. W. S., 40 years. Twenty-seven years ago without apparent cause sudden pain developed in the right leg, referred to the tibia. Gradually an abscess formed which discharged for twenty-four years. Four years after the disease started trouble developed with the right femur and the right humerus. There has been no discharge and comparatively little trouble for four years, but four days ago pain developed in the right tibia, which was severe, requiring morphia, and was incised a day or two afterward with some relief.

On physical examination there was a short, partially healed scar over the shaft of the tibia, through which many years ago an abscess of the bone was drained. In the upper and lower portions of this scar there are two areas from which there is some discharge. There was much thickening of the entire tibia as shown in the skiagram. (Figure 208.)

March 4, 1904. — An incision seven inches long was made over the tibia connecting various openings, and the tibia was found to be lying in a bed of pus, the upper half of the shaft being thus uncovered. Most of the pus was behind the bone. The greater part of the shaft of the tibia was removed subperiosteally and the accompanying X-rays show the gradual restoration of the bone from the periosteum.

October 10, 1904. — During the past six weeks the patient has been regularly at work on crutches, and there has been marked improvement in the general health and little discomfort in the leg. There is still a slight discharge from the lower part of the wound. The X-ray taken shows the formation of the bone well advanced. (Figure 208).

January 3, 1907. — Patient in excellent con-

dition and is walking about wearing a brace with a joint at the knee and using a cane. The leg is quite firm, there being little, if



Fig. 208.

FIGS. 208, 209, 210. This series, from Case III, demonstrates the reproduction of the tibia from the periosteum. The condition at time of operation is shown in this Figure. Figures 209 and 210 were taken fifteen months and three years later, respectively.

any yielding throughout the regenerated shaft of the tibia. There is comparatively little motion in the ankle joint and the foot is plantar

flexed fully 20 degrees, so that the gait is not as good as it would be if the foot were nearer a right angle. (Figures 209 and 210.)

May 2, 1907.—Tibia seems to be perfectly firm. There is moderate hyperextension of the knee when weight is borne upon it. This apparently is due to the weak ligaments.

January 9, 1908.—The patient is doing well and is to continue the bandage on the knee and try going without the brace. The plantar-flexion has been entirely overcome.



FIG. 209. Taken fifteen months after operation.

which can easily be mistaken for tuberculosis, syphilis, or malignant disease. Kocher describes this form, which is vascular, has acute suppurative exacerbations, produces a proliferating osteitis, and is chronic.

Palliative operations have failed to relieve. As the process

#### 4. Chronic diffuse.

The name chronic diffuse osteomyelitis has been given to an obstinate disabling form



progresses the joints are frequently invaded and their surfaces destroyed. Spicules of bone form along the shaft, and there is induration of the soft parts.

**Case IV. G. H. S. 34.**  
**Complaint.**—Right arm. **Duration.**—Six years; latest trouble, two years. **Cause.**—Supposed to have been a wrench of arm. **Symptoms.**—Pain and ache in arm first six years ago, not yielding to any treatment. X-ray at hospital and a surgeon at this time advised amputation. (See Figure 180.)

Operated upon and spicules removed. Healed well, and arm for four years was useful and practically as good as ever.

A little over two years ago fell on ice and struck elbow heavily. Very soon after this acute symptoms set in. Has had four or five operations since and as long as wound is open freely he has no pain.

Comes in now because of persistence of symptoms. Has lost weight. No other joint or bone trouble. General health fair.

**Examination.**—Rather poor general condition. Considerable



FIG. 210. Taken three years and three months after operation.

swelling extending from just below elbow joint to upper part of humerus. The upper half of upper arm very hard, suggesting a marked increase in size of bone. Thickening about elbow is softer with some superficial redness. Forearm much atrophied with practically no motion at elbow. Joint fixed in position of about  $50^{\circ}$  of flexion from a straight line. Two thoroughly healed cicatrices several inches long in upper part of arm and two others over elbow,

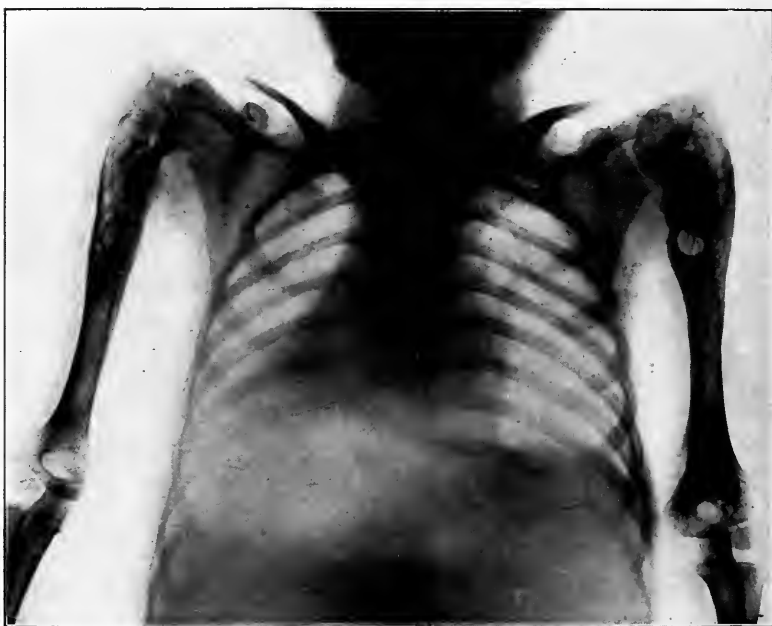


FIG. 211. Note the extensive disease near the heads of both humeri, extending down as far as the insertion of the deltoid. Motion is now surprisingly free in the shoulder joints.

one of which discharges slightly, the other of which is about ready to break down.

Treatment. — X-ray.

Diagnosis. — Condition suggests an osteomyelitis or an osteosarcoma.

The patient was referred to the hospital for operation. Specimen examined at the time of operation showed only a chronic inflammatory condition, but as the elbow joint was irreparably diseased

and it seemed impossible to obtain enough continuous periosteum to offer even a fair chance for bone regeneration, amputation was performed.

**Typhoidal osteomyelitis.** The bone lesions occasionally following typhoid are usually of an osteomyelitic nature, and occur in the second or third week of convalescence. They are ushered in by severe pain and are most common in the lower extremities. A swelling gradually appears. The skin is red and warm over the tumor, which has a doughy, elastic, or semi-fluctuant feel. The pain becomes boring or tearing in character and is worse at night. If the process is allowed to go on emaciation ensues like that in tuberculosis.

These lesions untreated may terminate in four ways.

(1) Absorption may occur, a definite periostitis remaining. This is the commonest course.

(2) The tumor may undergo cheesy degeneration, the granulation tissue resembling tuberculosis or syphilis. If unopened the fever persists until they spontaneously discharge.

(3) Liquefaction may take place, the fluid being reddish in color, odorless, poor in cellular elements, and giving a pure culture of typhoid bacilli if examined before secondary infection occurs.



FIG. 212. From the case shown in Figure 211. The same process was present in many other long bones.

(4) A sequestrum may be formed after a true osteomyelitis of this nature.

We have already called attention to the joint lesions following typhoid fever in which dislocations are so common an occurrence.

**Tuberculous osteomyelitis.** Tuberculous osteomyelitis of the shaft of the long bones is rare, but occasionally occurs. When for some reason the epiphyseal cartilage fails to completely protect the shaft from the neighboring joint infection we may have a secondary tuberculous osteomyelitis of the shaft. These cases are said to occur almost exclusively in tuberculosis of the shoulder joint.

The primary type, extremely uncommon, occurs usually in young children in whom there are multiple tuberculous foci. The tuberculous dactylitis and spinæ ventosæ may perhaps properly be spoken of as tuberculous osteomyelitis.

**Syphilitic osteomyelitis.** Osteomyelitis of a diffuse type may accompany syphilitic disease. The bone may be doubled or trebled in volume with numerous osteophytes and necrotic areas scattered throughout the shaft. Spontaneous discharge of necrotic material may take place. The bone may be in large measure destroyed, but under anti-luetic treatment regenerates to a marked degree.

**Osteomyelitis serosa or periostitis aluminosa.** The name periostitis aluminosa has been given to a more or less rare form of true osteomyelitis, in which the exudate accompanying the periostitis is of a serous or albuminous nature, containing fat and mucus. There exist more or less localized tender swellings near the epiphyses of the long bones. There is absence of high fever, and frank suppuration is usually not present. At operation there is found a periostitis with the deposition of lime salts. The fluid is reddish and serous in nature, and small inflammatory areas exist in the marrow. If growths are obtained from the cultures the staphylococcus pyogenes albus is usually found. The condition probably represents simply a true osteomyelitis caused by greatly attenuated bacteria. In the one case personally observed, recovery took place without operation. The urine may contain an albumen

known as albumose, which is to be differentiated from the ordinary albumen found in urine.

**Spinal osteomyelitis.** In one region however the early evidences of existence are so obscure, and the subsequent mortality is so high that it seems best before describing the disease, irrespective of locality, to consider osteomyelitis of the spinal column. This condition, although it may be at times unrecognized, is undoubtedly of comparatively infrequent occurrence, but of great significance. Its early recognition is the keynote of its successful treatment, which consists of free drainage and the removal of the necrotic bone tissue.

Makins and Abbott <sup>1</sup> draw the following conclusions from eight cases with post-mortem findings, which they personally observed, and thirteen cases reported by other men. Over one-half the cases occurred at an age between ten and twenty years, and in thirteen of the twenty-one cases the lumbar or sacral regions were affected. When the focus of infection was situated in the neural arch the abscess was in every case posterior, when the disease was in the vertebral bodies the abscess was anterior, and when the transverse process was affected the abscess traveled in both directions and was hardest to detect because of its depth.

The condition when an early meningeal infection occurs may easily be mistaken for a Landry's paralysis, or in the cervical region the symptoms may resemble a retropharyngeal or deep cervical abscess. A curvature or permanent kyphos is rare. The essential symptoms differ in no particular from an acute osteomyelitis in other bones, though the widespread area of soft parts affected in proportion to the area of diseased bone was striking in the autopsies. In all of the six cases in which bacteriologic investigations were made the staphylococcus pyogenes aureus was found.

Otto Hahn <sup>2</sup> draws practically the same conclusions from forty-one cases, and in the twelve cases investigated bacteriologically also found the staphylococcus pyogenes aureus. He considers that

<sup>1</sup> G. H. Makins, F. R. C. S., and F. C. Abbott, M. S., F. R. C. S., *Annals of Surgery*, May, 1896, vol. 23, page 511.

<sup>2</sup> Dr. Otto Hahn (Tübingen), *Beiträge zur klin. Chirurgie*, Band xxv, Heft 1.

the only essential difference from osteomyelitis of the long bones is that the periosteum shows little tendency to proliferation. (See Case II.)

### DIAGNOSIS

Considering again the diversity of types it is obvious that the diagnosis of the condition must be based on the symptom complex, which varies greatly.

The X-ray offers us our most accurate and reliable method, failing to help us only in those early very acute cases in which there is no marked cavity formation and no deposit of lime salts in the thickened periosteum.

We should disabuse our minds of the notion that osteomyelitis is always sudden in its onset and accompanied by high fever, great pain, and marked constitutional disturbance. This is the clinical picture of the fulminating type, but fortunately this is much rarer than the other forms.

### TREATMENT

For the **acute circumscribed** form the following outline of treatment is suggested:

Drainage.

Clearing out the cavity down to hard viable bone.

Disinfecting with Tincture of Iodine or crude Carbolic.

Tight closure or wicking for a short time only.

Temporary fixation.

For the **chronic circumscribed** form:

We should establish drainage with removal of sequestra.

Otherwise treatment should be as for the acute form, with a longer period of drainage.

**Acute diffuse.** Often simple drainage, especially in children, where the infection is not too virulent, allowing Nature alone to repair the lesion, will bring about very satisfactory results.

In the more severe cases, which do not progress favorably under drainage alone, total extirpation of the infected marrow is advised.

The reparative power in marrow is great, and even if the entire shaft is opened and the medullary canal cleaned, no bad results need be expected if care is taken not to injure the endosteum, by curetting. From the endosteum the inner layer of the cortex is formed and destruction of this will lead to necrosis of at least the inner layer. If there is marked cortical involvement the entire portion of the shaft involved should be removed, great care being taken to preserve the periosteum intact, since only from this or the endosteum can new bone be produced.

The results of this very radical procedure are almost always extremely good. Occasionally, under the most perfect technique, the periosteum forms new bone very sluggishly or completely fails to build the new shaft.

Berndt <sup>1</sup> believes that the essential conditions for regeneration after complete extirpation are leaving the periosteum intact and not closing the wound in order that the necessary irritation of the periosteum may take place. Be this as it may, the old surgical dictum not to remove the necrotic bone or sequestrum until it was fully moveable, that is, until an involucrum had formed, seems in light of modern knowledge and the work of Ollier <sup>2</sup> and Nichols to be wrong. (See Case III.)

The various methods which in the past have been tried to induce the filling up of cavities left by the late removal of definitely formed sequestra have been the sponge fillings of Hamilton, <sup>3</sup> recommended largely on theoretical grounds, the decalcified bone chip fillings of Senn, <sup>4</sup> and the method of Schede of allowing the disinfected cavity to fill with blood clot which subsequently organizes. Neuber <sup>5</sup> has closed the cavity by turning in flaps of skin and soft parts. By

<sup>1</sup> *Münchener Med. Woch.*, May 13, 1902, p. 74.

<sup>2</sup> Ollier, *Régénération des Os*. Paris: Victor Masson et Fils, 1867; Nichols, *Journal of American Medical Association*, February 13, 1904, p. 439.

<sup>3</sup> Hamilton, D. J., "On Sponge Grafting," *Edin. Med. Journ.*, vol. xxvii, p. 385, 1881.

<sup>4</sup> Senn, "Healing of Aseptic Bone Cavities," *Amer. Jour. of Med. Sci.*, New Series, vol. xcvi, p. 219, 1899.

<sup>5</sup> Neuber, "Zur Behandlung starrwandigen Hohlenwunden," *Arch. f. Klin. Chir.*, April, 1886, p. 62; also *Arch. f. Klin. Chir.*, vol. xxv, Heft 1, p. 316, 1879.

retaining them as linings of the cavity, he creates a skin-covered trough, which later, by the retraction of the cutaneous tissue, becomes obliterated.

The objection to the methods of Schede and Senn is the really great difficulty of rendering the bone cavity absolutely aseptic, without which the method usually, if not always, fails. Neuber's method would seem to be palliative rather than curative.

It is fair to mention the Mosetig-Moorhof<sup>1</sup> method. One hundred and twenty cases are reported with no failures where the cavity was enlarged into sound bone. The steps are careful asepsis and drying of the cavity, as in filling a tooth. There is then poured into it a semi-solid mass containing 60 parts Iodoform and 40 parts each of Spermacetti and Sesame oil. The ingredients are heated together to 80° centigrade for 15 minutes and then allowed to cool while the mass is constantly shaken to ensure the thorough dissemination of the Iodoform. For use it is heated again and shaken. The wound is closed. The possible advantage of this method is that the Iodoform shut off from the air may be expected to exert an antiseptic effect. We have had slight experience with this particular method, but our knowledge of the experience of others has led us to place little reliance on artificial fillings.

The most rational method would seem to be planned on the following lines. In the early acute cases, thorough drainage of the bone as well as the soft parts is demanded. The shaft should be trephined and a cap of bone removed until the marrow beneath ceases to exude pus or show marked infection. The marrow should not be curetted since preservation of the endosteum is most to be desired. In the later subacute stage removal of the entire necrotic bone should be undertaken. If this is simply a sliver along the shaft the operator may be satisfied with its removal, but if the necrosis encircles the shaft to a small or large extent, he should as fearlessly remove such portion of the entire shaft as is necessary to leave viable bone at both ends. Here the necessity of saving the periosteum becomes paramount, for from the two layers which may

<sup>1</sup> *Centralblatt f. Chir.*, Leipsic, vol. xxx, no. 16.



be stitched together to avoid a dead space a new and adequate shaft will subsequently be formed without sequestra or sinuses.

The opportune time for this operation is obviously before the formation of the thick completely ossified involucrum, but after the periosteum has begun to thicken and deposit bone. Where we have an accessory splinting bone, as, e. g., the fibula or one of the bones of the forearm, this opportune time is about eight weeks after drainage has been accomplished. It may be ascertained by Nichols' test of thrusting a needle through a sinus and recognizing the crackle of the ossifying periosteum as the needle passes through it and stops against the hard necrotic shaft. Microscopic examination of bits of periosteum near the sinuses will also more accurately determine the proper stage for operation.

Where there is no accessory splinting bone, e. g., in the humerus, the danger of subsequent contracture of the muscles and shortening demand that the removal of the necrotic bone be done at a somewhat later stage when the periosteum has formed a young involucrum of sufficient stiffness to preserve the length of the limb. Experimentation has shown that these young involucra have the power of forming new bone centrally as well as peripherally. About sixteen weeks after drainage has been accomplished is usually the most opportune time.

It is often advisable in locations where there is no uninvolved splinting bone, such as the fibula or one of the forearm bones, to leave a narrow bridge of the old, firm cortex, even if it seems likely to become eventually necrotic. This prevents subsequent shortening and favors a more symmetrical regeneration.

In the lower leg, when all attempts at regeneration of the tibia have failed, the fibula has been successfully transplanted by operations done in two stages. First one end and then the other have been inserted in the upper and lower tibial stumps, and an appropriate increase in size of the fibula has occurred, so that a useful weight-bearing limb has been obtained. (Codman, Stone.)<sup>1</sup>

Complete asepsis is ordinarily impossible and drainage should

<sup>1</sup> *Annals of Surgery*, October, 1907.

be provided for by sutures placed as far apart as suffices for approximation of periosteum and soft parts, and by small wicks for a short time.

A shaft capable of bearing weight may be expected to form in very favorable cases in six or eight months, but often, though ultimately forming, is not ready for function until a much longer time has elapsed.

Karewski,<sup>1</sup> in an article on the operative treatment of osteomyelitis, has called attention to the fact that often cases should be operated upon before any suppuration can be demonstrated. He advocates laying open the whole bone and removing the marrow.

In the chronic diffuse type we have a condition most obstinate in yielding to treatment. Not much can be expected from measures less radical than complete extirpation of the shaft with the periosteum left intact. Often the bristling osteophytes and necrotic areas have so destroyed the periosteum that little opportunity is offered for its preservation or its subsequent formation of bone.

Amputation has frequently to be resorted to in order to free the patient from a useless and menacing member.

<sup>1</sup> *Behandlungen der Deutschen Gesellschaft für Chir.*, XXIII Kongress, 1894.

## CHAPTER III

### RACHITIS

THIS disease demands a place in such a treatise as the present because its late lesions and its resulting deformities are usually not amenable to medical treatment and require apparatus or surgery for their management.

It seems probable however, if appropriate treatment is administered in its incipient stages, that the lesions later requiring surgery either never occur or may be corrected by very simple procedures.

The disease is acknowledged by all writers to be a nutritional disorder, a disturbance of metabolism which renders the bones more plastic, while their growth is disturbed by changes at the epiphyseal lines. These changes are expressed by swellings externally visible and by irregular zones of proliferation. The bony masses of the epiphyses as shown in the X-ray appear little if any enlarged, and the articular ends are regular in outline. The joints are unaffected except by the strain caused by faulty weight-bearing.

Among pathologists there is reasonable doubt as to whether such a thing as congenital rachitis ever occurs. Certainly, that disease spoken of as "foetal rickets" is quite a separate and distinct condition, and should be designated not as foetal rickets, but as "chondrodystrophia foetalis."

After the bone deformities have occurred the diagnosis can hardly be doubtful, but in the incipient stages, when the disease is essentially in its medical stage, the differentiation is more difficult. Profuse sweating, a rather large head, conveying the impression of squareness with its fontanelles, especially the anterior abnormally patent, is always suspicious. Areas in which the skull seems softened or thinned are often found. This so-called cranio-tabes is caused

by an abnormal thinness of the bones of the skull due to imperfect ossification in certain areas.

Enlargements at the epiphyseal lines, especially at the wrists and to a less degree at the ankles, are to be seen and felt. The classical sign of the "rosary" is produced by this swelling at the junction of the ribs and their cartilages. The "caving in" of the lateral chest walls and the protrusion of the sternum (Figure 213), "pigeon breast," which from its resemblance to the hull of a boat has also been called "pectus carinatum," is by far the most common rachitic thoracic deformity. In "cobbler's chest" the tip of the ensiform is markedly depressed, and in the rare form of "gutter chest" there is a sulcus formed by the costal cartilages dipping in toward the sternum. The so-called "funnel chest" is probably never due to rickets alone, although this disease may perhaps be a contributing cause. The question of the existence of adenoids and secondary changes in the lungs and bronchi should always be investigated in this latter deformity, since "funnel chest" often occurs in the absence of all other signs of rickets.

For a full discussion of these types the reader is referred to an excellent article by Dr. J. S. Stone.<sup>1</sup>

The abdomen attracts attention by its prominence and apparent distention. The liver and spleen are often found enlarged and the lower ribs flaring in consequence.

Scolioses, amenable to treatment in the early stages, but obstinate when the bones have become firm, are not uncommon. In rachitic affections of the spine the question of tuberculosis may well arise, since the kyphosis and sensitiveness to motion suggest the more serious condition. Almost never will the kyphos be found acutely angled, however, but rounding, involving a whole group of vertebræ, or indeed the whole dorsal and lumbar spine. Continuous recumbency effects a disappearance of the kyphos and of the lateral deviation.

Essential in the treatment of rachitis is a careful supervision of the diet and insistence upon an exact hygienic régime.

<sup>1</sup> *Transactions of the American Orthopædic Association*, vol. xi, p. 337.

No satisfactory etiology for the condition has ever been discovered. No essential connection with luetic taint has been conclusively proven, though it has been strongly argued. Much evi-



FIG. 213. This represents a marked case of pigeon breast. Note in the lateral view the retraction at the level of the diaphragm.

dence can be adduced tending to show that a lack of sunlight and fresh air is probably an even more important causative factor than a faulty diet.

The detailed arrangement of the diet is a problem for internists.

Fresh, properly cooked fish, fats which are easily assimilated, beef juice, fresh vegetables, and digestible fruit are among the most important elements. The drug treatment we believe to be entirely secondary in importance to sunlight, fresh air, and feeding. Minute doses of Phosphorus,  $\frac{1}{200} - \frac{1}{100}$  of a grain, have been believed to be of benefit. The syrup of the Iodide of Iron proves an excellent tonic. Cod liver oil has too great a traditional reputation to have its efficacy questioned.

If the incipient stage is thus combated, the lesions in the vast majority of cases will never require more than orthopædic consultation and will disappear without the intervention of surgery, and usually without the application of corrective apparatus. We are perhaps too ready to apply braces for the improvement of slight deformities which Nature with proper assistance will entirely correct. Apparatus entails great inconvenience and unhappiness on the parents' part and much discomfort on the part of the patient. Unless this correction is carefully and very accurately applied, although the rachitic deformity may be overcome, the secondary joint strain and atrophy induced are out of proportion to the correction obtained.

There still remain however many cases seen late in the course of the disease or especially resistant to medical treatment, which will demand orthopædic intervention.

The bones below the pelvis are naturally most prone to severe deformities, after the age of weight-bearing begins. Growth is much more rapid here than in other parts of the skeleton and changes are therefore most likely to occur in this region. Operation should as a rule be deferred until the age of four or five years since the bones rarely until that time attain sufficient firmness to guarantee a permanent result. Individual cases will constantly prove exceptions to this rule when on examination the bones are evidently firm and the disease entirely inactive.

A tracing of the deformity should be taken by laying the child on a piece of wrapping-paper and carefully outlining the contour of the body and limbs from the waist-line down. This tracing then

serves as a record. Subsequent tracings in different colors or with a different type of line are made over this at short intervals while the disease is active, and any progress toward a lessening of the deformity or an increase in the curvature is thus noted.

**Coxa Vara.** The first examination after the diagnosis is made should be of the hip joints in relation to an abnormal angle of the femoral necks. With the imperfectly forming and yielding bone the slant of the neck becomes more horizontal and the shafts tend to outward rotation. This obviously shortens the limb and interferes with abduction, the trochanter impinging on the ilium when this is attempted. A slight amount of coxa vara, as the deformity is termed, will be found upon careful skiagraphic examination to exist in many early cases of rachitis, but is a negligible condition if the disease in general is rapidly improving. Weight-bearing should evidently be restricted, if not forbidden, in all the rachitic deformities of the lower limbs until the bones have become firm and have lost the springy, elastic feel so characteristic of active rachitis.

In the more severe cases, after the disease has run its course and the deformity is so considerable that it represents a marked limitation to the abduction of the legs and a serious impairment of function, operative procedures are alone efficient for corrective treatment. These consist in oblique or subtrochanteric osteotomies of the femora, the lesion being usually bilateral and symmetrical. The limbs are retained in abduction by a double plaster spica or a Thomas splint and in six or eight weeks union is firm. A more normal angle is thus practically restored to the femoral necks.

**Femoral deformities below the neck.** Where the outward bowing of the femur is unaccompanied by the common anterior bowing, we may expect correction from braces if the disease is active. Osteotomies or osteoclases should be resorted to where the curve is complex or the bones firm and unyielding.

**Knock Knee and Bow Legs.** (Figure 214.) Knock Knee, or Genu Valgum, in early cases can usually be satisfactorily corrected by increasing the thickness of the heel and sole on the inner

side, by building up the arch of the foot by a plate or pad, or by both procedures. Thus weight-bearing is constantly exerting a corrective force, and the deformity will be seen to diminish in the record-tracing. The reverse of this procedure, that is building



FIG. 214. This shows the common rachitic deformities. There was a scoliosis, and various deformities of the radius, ulna, and humerus. Note the valgus, the antero-posterior bowing of both tibia and femur, and the knock knee. There was also marked coxa vara.

up the heels and soles on their outer sides, is of course available in bow legs, but its tendency to produce an undesirable valgus in the feet should limit its use.

Along with corrective shoeing should go frequent manual attempts at correction applied by the mother or nurse. Massage and stimulating bathing play their part in locally bettering the nutrition. In the brace treatment of knock knee only those braces which exert corrective force with the knee fully extended and which do not allow antero-posterior joint motion are efficient.

It will often be found on examination of rachitic de-

formities by means of the Röntgen ray that the seemingly general bend of the legs is in reality caused by a more or less acute bend just beyond the epiphyses. It can be appreciated therefore that in these types brace treatment applied efficiently for the correction of knock knee or bow legs must bring a tremendous leverage on the joint ligaments and be a questionable procedure. When we consider moreover that in both the femur and the bones of the lower leg spiral twists and multiple bends are far more common than evenly distributed curvatures, it is evident that the rational application of braces is limited to a comparatively small



number of cases. For this small number their use is called for and is satisfactory in results.

**Osteoclasia.** In nearly all the cases of obstinate outward bowing of the legs, osteoclasia is the operation of choice. For this procedure one of the many efficient osteoclasts should be employed. Manual osteoclasia has often been efficiently performed but is a far more laborious and less accurate method. The deformity is carefully corrected, the limb well padded and retained by plaster or accurately applied side splints. In four weeks union may be expected to be firm and the plaster or splints taken off at night. Weight-bearing, in case of firm union and the absence of recurrence of the deformity, may be begun in about six weeks.

The object of osteoclasia is to produce a "green stick fracture" of both bones at the apex of the deformity.

**Osteotomy.** When the most marked curvature occurs in close proximity to a joint, or when both lateral and antero-posterior bowing are present, osteotomy is the operation of choice. Undue strain on the joint is thus avoided and more accurate alignment made possible.

The after-treatment is the same as in osteoclasia, except that perhaps a little more care must be taken to determine that union is firm before allowing weight-bearing or discarding apparatus, since the section of the bones has been more complete.

Gant's name has been given to the subtrochanteric osteotomy of the femur for obtaining more abduction, Macewen's to osteotomy just above the femoral condyles for the correction of knock knee, and Trendelenberg's to osteotomy of tibia and fibula just above the malleoli.

If for any reason osteoclasts or osteotomies are performed before the bones have become firm or the disease inactive, after-treatment must obviously entail the use of retentive and corrective braces.

**Adolescent rickets.** While rickets is to a very large extent a disease of infancy and early childhood, it may occur at any period until adolescence is past. In the adolescent period a condition is

not uncommonly encountered which resembles closely infantile rickets. In the absence of etiologic and pathologic proof to the contrary the disturbance of metabolism is believed to be closely analogous to that in infantile rachitis. (Case 1.)

The commonest seat of the important lesions is in the femoral neck or at the epiphyseal line between the neck and head. Often no etiologic factor, no faulty hygiene can be discovered, and the disease attacks youth otherwise apparently in good health. It is more common among boys than among girls and is frequently associated with a tardy development of the genitals. Trauma, the carrying of heavy loads, etc., have been mentioned as etiologic factors, but it seems more probable to the writers that these can be only contributing causes accompanying an already existing metabolic disturbance.

This adolescent coxa vara is often first made manifest by a slight limp. It is sometimes unilateral, and when present on both sides is often not symmetrical.

Acute pain is almost always absent and easy fatigue in walking is due apparently to joint strain. Adduction and outward rotation of the leg are early signs, and an atrophy of thigh and calf, probably simply from disuse, is demonstrable in the unilateral cases. A certain amount of shortening and the elevation of the trochanter above the Roser-Nélaton line is usually present in marked cases.

The skiagraph offers the most certain and accurate diagnosis, and frequently reveals a separation of the epiphysis which resembles closely an intracapsular fracture. The neck is seen to be much more horizontal than normal, at times actually forming less than a right angle with the shaft.

The same general rules of treatment seem to be applicable to the later and adolescent cases as to the infantile type. The correction of faulty hygiene is, of course, of primary importance. The question of abstinence from all weight-bearing is not so simple to decide, since the inactivity which it entails exerts a deleterious influence on general metabolism.

Bed treatment and extension, recommended by certain writers, has in our hands not resulted in benefiting the condition or increasing the length of the limb. It seems rational therefore to advise the patient against long standing or walking or over-exertion of any kind, but to allow him restricted weight-bearing and mild exercise. No drugs have been proved to be of definite value except those which correct faulty bodily functions and improve general nutrition. Under this régime certain cases carefully observed by us have markedly improved. A more acute angle of the femoral neck has been regained, abduction has increased, and the subjective symptoms have correspondingly improved.

Certain other cases in the hospital class have on the other hand shown definite increase of the deformity where circumstances were such as to render a careful carrying out of advice impossible.

Sub- or trans-trochanteric osteotomies of the femur should be performed when after prolonged observation the disease is shown to have reached its limit and the deformity to be stationary. The after-treatment of the operative cases is carried out by fixation in plaster in an abducted position for eight weeks. Whitman believes that most of these cases represent true epiphyseal separations or fractures. He advocates removal of a wedge of bone from the great trochanter and abduction of the limb in a plaster spica.

Less commonly manifestations of the same morbid condition occur in knock knee or bow legs, again often unilateral. Treatment by mechanical devices is in the main unsatisfactory, and osteotomies of the bones after their plastic stage has passed offer the most certain correction of the deformities.

Although cases of coxa vara have been reported in later adult life, it is certainly extremely rare, if not unknown, to find typical rachitic lesions long after the adolescent period. The disease is a nutritional disease closely associated with growth, and is therefore most prone to occur at those periods of life when growth is most easily affected by nutritional disturbances. Bottle-fed, sunlight-starved babies and adolescents whose metabolism is in delicate

equilibrium will always show the most marked lesions. The two following cases, one a boy of 16 and the other a girl of the same age, are reported in this connection, though the diagnosis of their af-



FIG. 215. Note the epiphyseal enlargements at the wrists, knees, and ankles.

fections has not been positively established. There are many features of the two cases which strongly suggest osteomalacia, and yet there are many competent observers who are of the opinion that the lesions which patients of this class present in their bones are no further removed from the essential changes seen in infantile rachitis than they are from those observed in osteomalacia and that, in other words, the condition sometimes called adolescent rickets is really a connecting link between the two. There is considerable evidence to support this view. Osteomalacia in man is rare. These two cases present very striking clinical and pathological resemblances and yet they are of opposite sexes. The writers, therefore, prefer to class these two cases under the head of adolescent rickets, recognizing the

fact that the existence of such an entity has not been established, but believing there is ground for expecting such an outcome to present and future investigation.

**Case I.** (Figures 215 and 216.) G. M. G. 15 years. Male. Adolescent Rickets. The patient is the youngest of a family of seven, all

of whom are well. He has always been in good health. A year and a half ago first noticed enlargement of wrists, knees, and ankles. This increased gradually. Six months ago the swelling in the knees became quite marked and a knock knee developed which in the left leg has become so prominent that he has been obliged to use crutches in order to get about. The other lesions have remained stationary. General health has apparently been good in spite of the changes noted.

On physical examination there are marked epiphyseal enlargements of the lower ends of the radii, a well-defined rosary, and epiphyseal enlargements of the tibiae and femora. In the left knee there is fully 50° of knock knee.

A lesser degree of the same deformity is present on the right.

Osteotomy was performed to correct the deformity. After the skin incision was made the chisel was easily pushed through the bone without the aid of a mallet, and the necessary wedge excised. The section of bone was very vascular and the intratrabecular spaces were filled with a semi-gelatinous tissue.

The X-ray appearances are shown very well in the accompanying prints. (Figures 217, 218, 219.)

Histologically the section shows an osteoid tissue, the bone beams being surrounded by osteoblasts and osteoclasts in large numbers. (Figures 220 and 221.) There is very close resemblance to the section of bone made from the femur of a patient suffering from osteomalacia. (Vide Case II.)



FIG. 216. Note the extreme degree of knock knee. An operation was performed upon this, and from the femur was obtained the material shown in the microphotographs, Figures 217 and 218.

**Pathological report.** Received in formalin. Wedge-shaped specimen consists of mass of bone at one end of which are nodular masses



FIG. 217. Note the coxa vara and the shortening of the femoral neck. The osteoid character of the bone has rendered the passage of the X-ray easy.

of cartilage varying from 0.5 to 0.8 cm. in diameter and in places apparently sharply marked off from one another.

Cross section shows bone to consist wholly of soft spongy structure through which the saw cuts with ease.



FIG. 218. Note the wide separation between the epiphysis and the diaphysis, and the irregular shape of the latter.

Microscopic examination reveals apparently isolated masses of cartilage to be part of a single cartilaginous structure (epiphyseal?)

which has been divided incompletely into separate masses by vascular connective tissue and small islands of ossification.



FIG. 219. Observe the marked knock knee, and the marked separation of the epiphyses and diaphyses. The radiability is much diminished.

The epiphyseal line is not markedly irregular. The cartilage near the line stains less deeply with basic dyes than does the cartilage



of normal ossification. Cartilage cells are evenly distributed and do not show the normal row formation at junction. Here and there however are small areas where an evident attempt has been made at row formation and in these foci the cartilage cells show the deep characteristic basophilic character.

The trabeculae of bone away from the epiphyseal junction are large and show a rim of osteoid tissue on edge near marrow. The islands of bone in epiphyseal cartilage are wholly osteoid in struc-

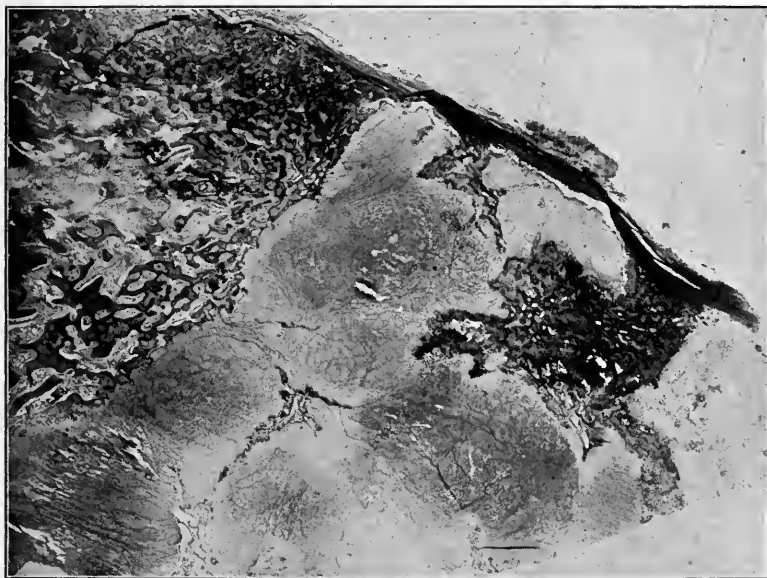


FIG. 220. Low power of section from case shown in Figure 216. For pathological description see text of Case I. Cf. Figure 225.

ture and the cartilage about them shows evidence of recent proliferation; i. e. many capsules surround groups of several cells and the cell bodies take a strong eosin stain. Many of the beams lie closely in touch with the inactive portions of cartilage. The more recent beams are covered by perfect rows of osteoblasts, but older trabeculae show only occasional cells. Along older beams osteoclasts are reasonably abundant. There is no cortical layer of bone. The trabeculae and cellular intertrabecular connective tissue are united directly to the periosteum.

The marrow spaces are filled with young connective tissue in which are scattered relatively few marrow cells. Along periosteum and near epiphysis the connective tissue is so cellular as to be sarcomatoid in character. In central portion sinusoids are large in places occupying most of the marrow spaces, and the connective tissue is less cellular. In these regions small round cells are more abundant.



FIG. 221. High power from case shown in Figure 216. Cf. with Figure 225.

**Case II.** Name. — E. J. Age, 16. Female.

Deformities of hands and wrists, and of legs, with inability to walk.

Family history. — No tuberculosis, joint affections, or neoplasm. Mother married at nineteen; nine children; all births, except last, natural and easy; all but last are living, well, and strong. None are affected like patient. The last lived but five days; foot presentation; instrumental birth. Four boys; five girls.

Personal history. — Patient was the eighth child. Measles when aet. 9 years; no other illnesses. Has always been clever and bright

at school. Head always large for body. To age of twelve years grew very fast and was always perfectly straight-limbed and well-formed. Has never menstruated. No peculiar dietary habits. Lived till æt. 13 years in Lancashire, England. Parents have seen no similar affection in that region. No history of bladder troubles.

Present illness. — During summer of her 12th year, with no history of previous illness or trauma, patient began rapidly to develop a double symmetrical knock knee. (Figure 222.) Six months later, with the condition progressing, osteoclasia below both knees was performed by local physician (chloroform). In bed, legs in plaster, for three months, then up on canes. Both knees were "enlarged," but did not show the present curves. Knock knee was corrected. About ten months after operation came to the United States. X-rays taken. Mother



FIG. 222. Note the deformities which represent fractures at the wrists and knees.

says that patient had a lumbar lordosis and a decided prominence of right hip, due to recent fall. The knees were same as after operation, and other deformities absent. Two plasters for four months. Result: — Symmetry and ability to walk considerable distance unaided, but generally used crutches. Since then patient has had frequent falls, but no history of any fractures, except doubtful history in right shoulder joint. (Splint and sling for six to seven weeks.) Twelve to thirteen months ago first noted gradual curving above knees; a little later wrists were similarly affected. No explainable cause, except frequent falls. Condition has lately been growing rapidly worse. Four months ago fell, and left leg was supposed to be fractured. Improved by plaster kept on

for nine weeks. At present cannot stand, on account of deformities, etc. General health good. Eats and sleeps well. Has no pain. Sweats considerably at night. No cough. Bowels constipated.

Physical examination. — Color (conjunctival and mucous membranes) fair. Pupils = and react to light and accommodation. Tongue clean. Palatal arch rather low. Teeth well formed and preserved (not Hutchinsonian). Head large for even an adult. Forehead broad, slightly convex; no bosses; height moderate. Malars very large and thick and rather prominent. Nose small and saddle-shaped. Expression pleasant and intelligent. Maxillary bones not over-developed. Bitemporal and occipito-frontal diameters of head disproportionately large. Occiput overhanging. Cranial surfaces smooth.

Submaxillary glands enlarged to pea-size; several on each side. Slight enlargement of inguinal glands on both sides. No other glands felt. Thyroid very soft; no enlargements. Skin everywhere well nourished, with urinous odor from frequent moderate sweating. Marked venous pulsation in vessels of neck. Pulse regular; good volume; moderate tension. Knee jerks present and equal. No ankle clonus or Babinski.

Thorax. — Symmetrical with marked "rosary" and Harrison's grooves. Superficial mammary veins enlarged. Breasts large and firm. Clavicles arch forward and very prominent at sternal ends, making a deep episternal notch; no evidence of fractures.

Lungs. — Expansion good and equal. Marked tympanitic quality on percussion throughout both fronts, especially over right apex, but flat above left clavicle. Breath sounds throughout fronts very loud and clear, except for dry atelectatic (?) rales heard distinctly on inspiration at both bases, not disappearing on cough. Backs also clear, except for same rales at both bases.

Heart. — Apex beat palpable, but not visible; maximum in 5th interspace, 7 cm. from midsternal line. Area of cardiac dullness not increased. Both sounds everywhere sharp and clear. Pulmonic second sound increased.

Abdomen. — Soft and natural in appearance. Relative hepatic

dullness begins at upper border, 6th rib in para-sternal line, and absolute hepatic dullness 1.6 cm. lower, extending 3 cm. below costal margin in same line, and in anterior axillary line reaches tip of 9th rib. Lower border of liver is palpable 3 cm. below lower border of dullness in nipple line on right; is smooth and soft. The soft lower border of spleen can be felt on deep palpation 3 cm. below left costal margin in para-sternal line.

Kidneys. — Left is easily palpated, not enlarged, moveable, or tender. Right is just palpable. Abdomen otherwise negative.

Pelvis. — Pubic symphysis moderately beaked. Anterior superior spines in apparently normal relative positions.

Upper extremities. — Right humerus, — head luxated forward, upward, and internally rotated. Shaft in upper one-half presents a gentle curve, concave externally. Rotation at shoulder free. Lateral raising beyond  $55^{\circ}$ – $60^{\circ}$  from vertical impossible. Posterior elevation also restricted. Anterior elevation only  $45^{\circ}$  beyond position of rest. Passive motions similarly limited. On gentle traction the dislocation can be partially corrected.

Left humerus presents a similar less marked dislocation; upper one-half of shaft more curved with convexity anteriorly, and bone shows pronounced irregular callus thickening. Lateral elevation as on right. Almost no anterior elevation possible, and posterior elevation markedly restricted.

Right forearm, when held with flexor surface upward, shows marked deformity above wrist. The lower one-third of radius is curved sharply toward flexor surface, forcing hand into permanent semi-pronation, beyond which supination is impossible, but allowing complete pronation, and throwing lower end of ulna into extreme prominence. External border of radius presents an irregular small bony ridge in lower one-half (history of old trauma). (Figure 223.) Intrinsic wrist motions free. Right hand: — Metacarpals all present bowing; dorsal convexity. Distinct clubbing of all finger tips, and considerable atrophy of all middle phalanges. Congenital (?) permanent flexion of 5th proximal interphalangeal joint. Left forearm presents somewhat similar deformity to right. The curve in

radius is longer and gentler, and accompanied by a decided lateral curve (external concavity), so that with arm fully extended and flexor surfaces up, the articular surface at wrist looks directly to the right. Supination better than on the right, but not complete.



FIG. 223. Illustrates the spontaneous fracture of the humerus and radius. Observe the cyst formation in both of these bones, and the extreme deformity of the wrist due to fractures of the lower end of the radius and ulna.

Wrists and hand as on right, except for absence of metacarpal bowing and congenital deformity.

Lower extremities.—Show extraordinary symmetrical deformities. Right femur:—Beginning with the trochanter, which is 2 cm. above Nélaton's line, the upper four-fifths of shaft is bowed,

with a marked external convexity. About 2 inches above condyles shaft curves sharply backward and inward, causing the articulating surfaces to present almost directly backward (or, as the patient lies, downward), and the patella to look downward and inward. Right tibia is subluxated backward, with a compensatory, anteri-



FIG. 224. Note the fracture of the femur. This was made in an attempt to correct the knock knee deformity before the condition of the bones was known.

only concave curve just below the head, and slight lateral bowing of shaft; concave externally. Left femur (Figure 224): — Presents to an extraordinary degree same deformities as the right. The lateral curve in shaft is extreme, maximum in upper one-third, causing a great prominence of thigh. Trochanter is 3 cm. above Nélaton's

line. The whole shaft is thickened, especially at maximum of upper curve, and is sensitive to pressure. The bending above femoral condyles is at almost a right angle. Left tibia:— Same deformity as right; slightly more lateral bowing. Both tibiæ of equal length (knee joint to external maleolus). Symmetrical atrophy of both legs and of considerable degree.

Motions. — Right hip allows almost complete extension (voluntary and passive), but no hyperextension. Adduction full; abduction much restricted; rotation limited, especially inward. Left hip:— Extension less than on right; adduction and abduction as on right. Rotation unusually free, both directions. Right knee:— Patella free. Lateral motion possible through arc of about  $15^{\circ}$ , with also considerable rotatory motion. Left knee:— Same, with more lateral, but less rotatory motion.

Knee jerks present and equal. No ankle clonus or Babinski.

Feet and ankles:— Motions all very good. Longitudinal arches easily obliterated, bringing scaphoids on level with soles.

Back:— As patient cannot stand or lie flat on abdomen, spinal deformities are not accurately seen. Is apparently a slight total curve, concave on left, with considerable posterior rotation of right ribs in lower dorsal region. The 12th dorsal, and 1st, 2nd, and 3rd lumbar spines are large and prominent.

The facies and various deformities are well seen in the photographs and X-rays. The latter show typical green-stick fractures above both femoral condyles and remarkable bowing, and in some cases torsion of the long bones. The structure appears to have undergone considerable rarefaction, and the cortex and periosteum, especially in the metacarpals and phalanges, show deficiency of lime salts and irregularity of outline.

(Figures 222, 223, and 224.) Compare with the illustration of an adolescent rachitis (Figures 215, 218, and 219); also with Chondrodystrophia Foetalis (Figure 228), and Osteogenesis Imperfecta (Figure 226).

Two metabolism experiments are here given which indicate a decided retention of sulphur as the most conspicuous feature.



*First Metabolism Experiment*

Urine.	CaO.	MgO.	P <sub>2</sub> O <sub>5</sub> .	S.	N.
First day .....	.659	.1124	1.1238	.1838	6.944
Second day.....	.504	.0819	.9352	.1958	5.682
Third day .....	.597	.1036	.9912	.2150	5.362
Fourth day .....	.439	.0913	1.0270	.2166	6.456
Fifth day .....	.380	.0754	1.2896	.1796	6.458
Sixth day .....	.343	.0565	.8992	.1856	5.680
Seventh day .....	.647	.0750	1.3122	.1882	8.622
Eighth day .....	.290	.0710	1.2310	.1424	5.838
Sum .....	3.859	.667	8.809	1.517	51.04
Feces .....	1.80	1.348	3.568	1.166	11.98
Total excr .....	5.66	2.015	12.37	2.68	63.02
Food.....	4.56	2.207	12.05	7.15	69.12
Retained (gms.) ....	-1.10	+0.192	-0.32	+4.47	+6.10 gms.
Retained % of amt. of food .....	-24%	+9%	-2.7	+63	+9

Weight at beginning, 59 lbs. At end, 59½ lbs.

**Pathological report.** Received in Zenker's fluid several fragments of bone which include cortex and marrow.

Specimen had been in Zenker's fluid, which contains acetic acid, for a long period before it was presented for examination, so that conclusions as to consistency, etc., were unsatisfactory.

Microscopic examination.—There is no cortical layer of bone. Periosteum consists of a thick layer of dense and relatively avascular connective tissue. This tissue is in places almost cicatricial in character and vessels are small and occur in groups, showing some evidence of compression, much as they are found in old scar connective tissue (e. g., base of an ulcer). Its inner layer, on the contrary, is very cellular and has the general character of very young granulation tissue. The trabeculae of bone at the periphery abut on this dense fibrous tissue much as they normally abut on the cortical layer of bone. The trabeculae are relatively of normal size for the most part. The character of the tissue, whether osseous or osteoid, is difficult to determine on account of the age of the specimen. (Figure 225.)

The bone beams in the cortical region are surrounded by a con-

tinuous layer of osteoblasts. The marrow spaces are filled with a very vascular connective tissue. Near centre of bone osteoblasts are less prominent along trabeculae and many beams are surrounded by great masses of osteoclasts. Some of the trabeculae are separated

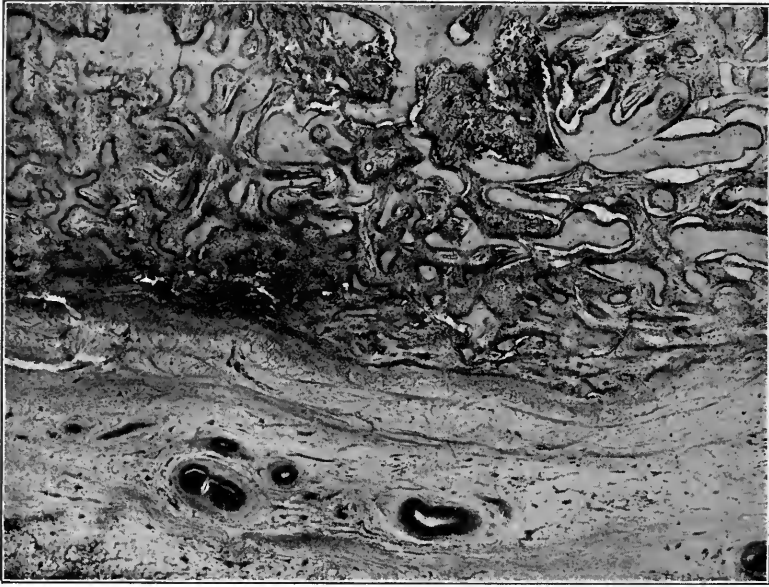


FIG. 225.

Vide pathological description of Case II in text. Cf. with Figures 220 and 221.

from connective tissue of marrow by spaces which are irregular in outline and are not lined by endothelium. These spaces contain large mononuclear cells, with an occasional polynuclear, and the trabeculae, which they surround, are small and show evidence of erosion.

Marrow spaces near central portion of bone are largely filled with vascular connective tissue, but some spaces contain groups of fat cells.

Diagnosis. — Osteomalacia — active stage.

## CHAPTER IV

### OSTEOGENESIS IMPERFECTA

THERE has existed in the past much confusion in regard to the classification of the so-called foetal bone diseases. It has indeed been stated that our knowledge warrants no separation into types (Ballantyne). This statement however does not seem to be true of the disease called by Vrolik "Osteogenesis Imperfecta," especially in light of the very careful work on the histology of this condition which has been done by Nichols in a case reported by Lovett.<sup>1</sup> These findings seem to make it possible to identify the pathologic process while the clinical picture is so definite and so essentially different from foetal rickets, falsely so-called or Chondrodystrophia Foetalis, that the disease should be easily recognized as an entity.

The condition occurs in utero and its causes are as obscure as they were in 1763 when the first case was published (Bordenave). Heredity has been thought to be a factor, but in many of the reported cases not the slightest history of similar trouble in the families could be elicited. An excellent monograph by Nathan<sup>2</sup> calls attention to the fact that some cases of undoubted osteogenesis imperfecta live after birth and attain adult life, the characteristics of the disease persisting but with diminished severity.

The confinement may be entirely normal as far as our present knowledge goes. The new-born child resembles at first glance the more frequently recognized chondrodystrophia foetalis. The resemblance ceases however with the thickened skin and subcutaneous tissues which are usually less marked than in the former disease or perhaps quite normal. The bones moreover (Figures 226 and 227), while often bent and twisted from the fractures which have occurred in utero, are in the cases seen by the writers not other-

<sup>1</sup> *British Medical Journal*, October 13, 1906, p. 915.

*American Journal of Medical Science*, January, 1905.

wise shortened or bowed as in chondrodystrophia. Lovett states that bowing of the tibiae is common as in his case. The cranial



FIG. 226. Observe the numerous fractures, which were spontaneous, also the bowing of the long bones, the flaring diaphyses, and the rarefaction of the medullary tissue in certain places.

sutures are not synostosed but on the contrary often widely open. The characteristic prognathus of the chondrodystrophic child is also absent in osteogenesis imperfecta. Non-union of these intra-

or extra-uterine fractures is rare, and callous formation, though apparently diminished, is present, giving a bone fractured in several places a nodular feel.



FIG. 227. As in Figure 226 there have been numerous spontaneous fractures with much overriding of fragments in places. There is also a marked rarefaction of the upper portion of the right tibia and bowing of the other long bones.

All the bones are fragile and prone to fracture on the slightest provocation. The spinal column is often curved laterally or antero-posteriorly while the cranial and other flat bones take part in the general deficiency of the osseous skeleton.

Many of the cases reported as idiopathic fragilitas ossium undoubtedly should be considered instances of osteogenesis imperfecta. There remain a small residue of reported cases in which the fragility evidently occurred later in life and was not associated with any traceable intra-uterine or congenital disease, and it seems improbable according to Nichols that the process in osteogenesis imperfecta is identical with the acquired fragilitas ossium.

The reader is referred to the article of Lovett and Nichols above mentioned for the detailed report of an apparently typical case, with excellent microphotographs of the pathologic process, a careful description and a review of the literature.

An epitome of the fine differences between the process of ossification in normal bone and in osteogenesis imperfecta is the following quotation from Nichols:

"The epiphyseal line was in all cases curved (instead of straight, as in normal bone), but clearly marked and not toothed as in rickets."

"The distinction is that in normal ossification the trabeculae are formed chiefly by apposition of bone by osteoblasts upon persisting cartilaginous matrix, while in this case new trabeculae are formed by direct metaplasia of persisting cartilage cells into bone. In normal bone the trabeculae become laminated and the bone cells become stellate with canaliculae connecting adjoining cells. In this case the bone cells always remain large, oval, not stellate, show little or no tendency to form connecting canaliculae and are much more numerous than normal. The trabeculae also show no abnormal lamination. The periosteum also does not form normal bone. Under normal conditions the cortex consists of a continuous layer of laminated dense bone in which are stellate bone cells and Haversian canals. In this case instead of a continuous layer of normal bone the periosteum forms separate plates of non-laminated or imperfectly laminated dense bone in which are oval bone cells and no Haversian canals. Instead of Haversian canals are large marrow spaces. The trabeculae in the marrow canal are much less numerous than is normal."

The process of bone formation everywhere is checked and of an abnormal kind.

Thus it is seen that even in the light of modern pathology we are still unable to formulate any hypothesis of cause. No drug or method of treatment other than the obvious one of preventing fractures and improving in every way the general nutrition has influenced the course.

As Nichols suggests, the careful microscopic study of the placenta in these cases seems to offer some hope of at least coming one step nearer the hidden etiology.

The cases are not necessarily fatal, Lovett's case dying at ten months from some other cause not directly traceable to this bone disease. Nathan has also shown that adult life may be attained and that if early years are survived the bones apparently become less brittle and fracture less frequent. The mental condition seems to suffer no impairment and the other bodily functions remain normal.

## CHAPTER V

### CHONDRODYSTROPHIA FÆTALIS

CHONDRODYSTROPHIA FÆTALIS, often erroneously called "foetal rickets," is a disease the essential feature of which is a defective growth of the enchondral skeleton.

The enlargement of the head, the bowing of the limbs, the frequent enlargement of the epiphyses, and the presence of a rosary, at first glance seem to connect it closely with rachitis, but more careful pathologic study reveals it to be an entirely different condition.

The thickening of the skin and subdermal tissue, with the large lips, heavy eyelids, protruding tongue, and facial deformities almost as strongly suggest cretinism, but no abnormality of thyroid secretion has been found to be present, and the resemblance disappears without thyroid therapy in those cases which grow up to adult life. The condition is also widely separated from the so-called osteogenesis imperfecta, as has been shown.

It is apparently always a congenital disease, with a very high mortality, the majority of infants so affected being born prematurely or dead at term. If born alive they are weaklings for varying periods, but if they then survive seem to develop a normal resistance for the rest of their lives. The condition is probably more common than supposed, and from the reported cases seems to affect the female sex somewhat more frequently than the male.

#### ETIOLOGY

As far as we are aware no one has suggested, far less proved, any satisfactory etiology, and the prenatal conditions conducive to this process are nearly as obscure as when the first recorded case was reported by Sömmering<sup>1</sup> in 1791.

<sup>1</sup> Sömmering, *Abbildungen u. Beschreibungen einiger Misgeburten, etc.*, Table xi, Mains, 1791.



The essential clinical characteristics are as follows. Prognathus with retraction of the nose is almost constant. Some or all of the epiphyses are enlarged. The bones of the extremities are much



FIG. 228. Note the diaphyseal flaring, the bowing of the femora, and the coxa vara.

shortened and appear thickened, although probably only because the normal relation of length to thickness is changed. This shortening of the limbs produces the dwarfing so characteristic of the adult cases and so noticeable in infants when one compares the length of the trunk to that of the limbs. The arms reach hardly to the waist-line and the legs are short and stubby. Both sets of extremities are often bowed. (Figure 228.)

In those cases surviving the critical foetal and infantile period the mental acuteness seems to be in no way diminished and they apparently retain through life a normal mental condition.

The pathologic explanation of the condition has been made much clearer in recent years by the work of Eberth, Schidlowsky, Krichberg, Marchand, and especially Kaufmann, which has been reported in English by Nathan in an excellent monograph.<sup>1</sup> It has been discovered by these researches that the constant pathologic lesion in every case is a defective row formation of the cartilage cells essential to normal enchondral bone growth. This row formation is always disturbed, sometimes almost rudimentary. Other characteristic pathologic lesions are found and chondrodystrophia has been divided by Kaufmann into three types, according to which one of these other less constant pathologic lesions predominates.

Thus in one type in addition to the defective row formation there is greatly diminished proliferation of the cartilage cells, "Chondrodystrophia Fœtalis Hypoplastica." Here the epiphyses are not enlarged. In another type, although the row formation still remains rudimentary, the proliferation of the cartilage cells is enormously increased, "Chondrodystrophia Fœtalis Hyperplastica." The epiphyses are greatly enlarged. In still a third type there is marked increase in the intracellular substance and the cartilage cells are scattered about in this mass, "Chondrodystrophia Fœtalis Malica." The epiphyses are here very soft and almost gelatinous. These various types may be found coexistent in different epiphyses in the same case.

<sup>1</sup> P. W. Nathan, *American Journal of the Medical Sciences*, April, 1904.

The bone which is formed from connective tissue and the very early ossifications are unchanged, while the deposition of calcium salts and periosteal bone formation proceeds in a normal manner.

Between some of the diaphyses and epiphyses will be found inclusions of periosteum, which retards if not prevents further growth in length. The exact method of production of this so-called "periosteal lamella" is not certain.

#### TREATMENT

As to the treatment of this disease, which begins "in utero," there is little at present to be said, and it is obvious that we know no way of controlling or influencing it. Something can be done in the way of osteotomies to correct the deformities, but these should hardly be undertaken until the bones have become firm and the general health well established.

The prognosis for life and healthy mental and physical activity would seem to be good after the critical infantile period is passed.

## CHAPTER VI

### OSTEITIS DEFORMANS

FOR the first careful description of this disease we are indebted to Sir James Paget. On account of his papers, published in 1876-77, the condition has commonly been known as Paget's Disease. The paucity of reported cases and the failure to recognize the clinical picture has led to the general belief that the condition is one of great rarity. At present, we realize that its occurrence is much more common than is supposed, and its diagnosis, by means of the X-rays, is greatly simplified.

The insidious onset, often long before senile changes are marked, is occasionally demonstrated in skiagraphs taken for other suspected or real lesions and proves conclusively that the human body is subject to this disease much earlier than was formerly believed. Dr. E. A. Locke and the writers have collected twenty-six personally observed cases, in one of which the disease evidently began at the age of twenty-seven years.

When one has the common deformity clearly in mind it is often possible to pick out cases on the street, and several have been thus casually but correctly diagnosed by the writers. (Figure 229.)

#### ETIOLOGY

Of the etiology of the disease we know practically nothing. It would seem to represent, as we believe the chronic hypertrophic and atrophic types of joint disease represent, some derangement of metabolism affecting the shafts of the bones. We may suppose some loss of balance between waste and repair, perhaps brought about by the hyper- or hypo-secretion of some of the glandular tissues of the body which interferes with the normal bone-forming or bone-destroying mechanisms.

The researches of the physiological chemists help us a little.

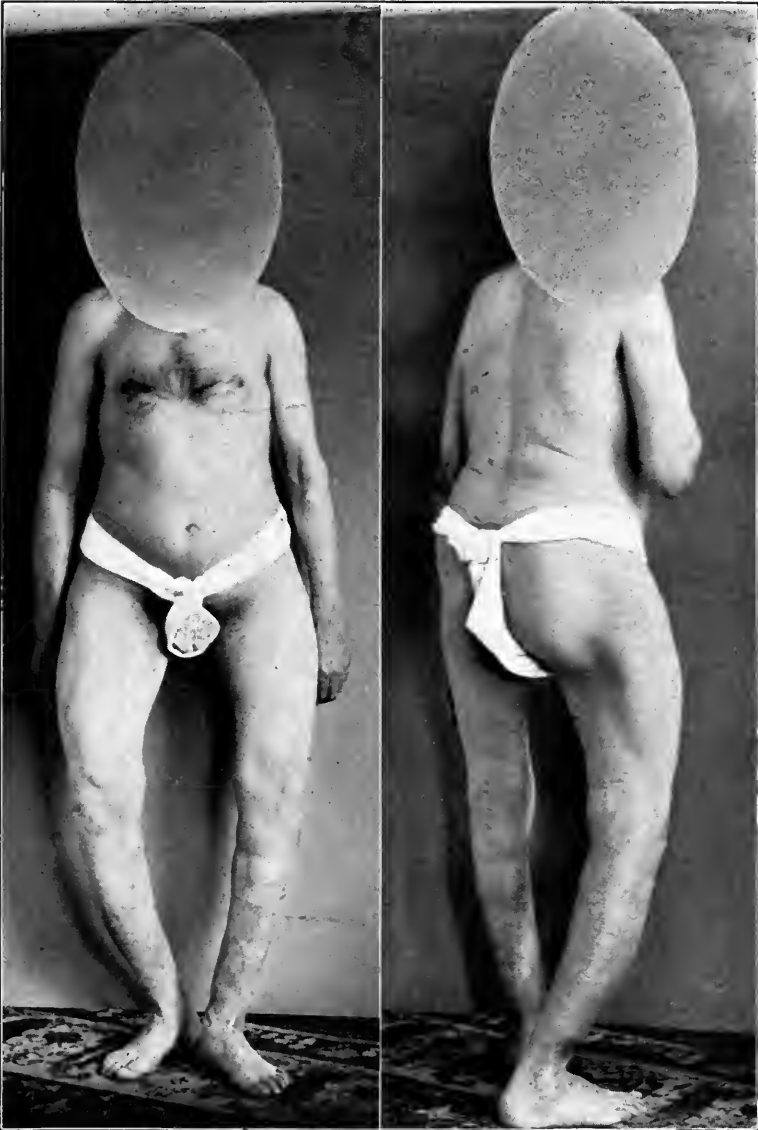


FIG. 229. This represents the common lesions of Paget's Disease. The stature is much diminished in height. Observe the bowing of the femur and tibia. The thighs are rotated outwardly.

The work done by McCrudden on the chemical metabolism under the direction of the writers may be summarized as follows:

A case of osteitis deformans. In this experiment the calcium in the urine was high, the magnesium a little low. There was a small loss of phosphorus and a slight retention of calcium and magnesium.

Urine.	P <sub>2</sub> O <sub>5</sub> .	CaO.	MgO.
First day .....	2.156 gm.	.2875 gm.	.1832 gm.
Second day.....	1.835 "	.4015 "	.1176 "
Third day.....	1.859 "	.4915 "	.1450 "
Fourth day.....	1.693 "	.3595 "	.1066 "
Fifth day.....	1.678 "	.4900 "	.1345 "
Sixth day.....	1.795 "	.3005 "	.0870 "
Seventh day.....	1.791 "	.3660 "	.1149 "
Eighth day.....	.822 "	.1905 "	.0353 "
Total.....	13.63 gm.	2.887 gm.	.924 gm.
Feces.....	8.89 "	6.63 "	2.319 "
Total output.....	22.52 gm.	9.52 gm.	3.243 gm.
Food.....	21.28 "	10.18 "	4.047 "

Weight at beginning of the experiment.....140 pounds.

Weight at end of the experiment .....140 pounds.

Total amount of sugar eaten during the experiment.....182.0 gm.

Total amount of salt eaten during the experiment..... 14.5 gm.

Paper used after stools..... 40.44 gm.

The rare complete autopsies tell us little more than the histology of the pathologic bone, without obtaining any clue as to the exact nature of the etiologic factors.

In our cases, where there could be discovered any likely pre-disposing cause, sedentary life and physical or mental over-exertion, coupled with a more or less "nervous" disposition, seemed to be the only common factors.

#### MODE OF ONSET

The disease often begins so insidiously that the patients seek medical advice only because of slowly increasing deformity. Questioning will often reveal that the condition must have been long existent. For example, it can be ascertained that they have from

time to time been obliged to purchase larger sizes of hats, owing, of course, to the thickening of the cranial bones.

Very frequently however the element of pain is the reason for seeking medical advice. This discomfort is ordinarily not severe, and may or may not be sharply localized in one or more bones. The lower limbs are, as a rule, complained of earliest, and probably are most commonly first affected. The tibiæ in our cases have shown the earliest changes.

#### COMMON COURSE

The disease progresses, affecting more and more of the bony framework, the deformities increasing. These deforming symptoms consist in a thickening and bowing of the bones. The cortex is usually thickened more on one side than on the other, and often gives rise to the bowed appearance, one side remaining almost straight. (Figures 230 and 231.) Areas of rarefaction occur and the medullary canal may be almost obscured, strong bony trabeculæ bridging the space. More rarely, acutely sensitive swollen areas develop, exquisitely tender, with the skin over them somewhat reddened. We have never seen these spontaneously open, and when incised no pus is found, but simply chronic inflammatory tissue. No bacterial growths have been obtained from these or any other lesions of the disease.

New bones may become affected without the knowledge of the patient, and give rise to no subjective symptoms. One of the most striking instances of this occurred in a noted organist and pianist whose hands were X-rayed in the routine examination of a well-marked case. Several of the metacarpals and phalanges showed definite changes, which would seem to have been of long duration, yet had not interfered with his vocation in the slightest appreciable degree.

The bowing of the legs may increase to such an extent as to necessitate a cross-legged or scissor-like gait, and to seriously interfere with the motion at the hips. The arm bowing similarly affects the motion of shoulders and elbows.

## ASSOCIATED SYMPTOMS

Except for the inconvenience of locomotion and the interference with free motion, the associated subjective symptoms, other than



FIG. 230. This and Figure 231 are taken from the case shown in Figure 229. Note that the fibula is not involved in either case. Note the rarefaction in this Figure and the great density in Figure 231, which is the other leg of this same case.

those of general easy fatigue, are slight. The painful areas above mentioned and the joint strains, from the necessarily faulty weight-bearing, often give rise to symptoms more or less acute.



## ASSOCIATED LESIONS

Arteriosclerosis is so common an accompaniment of the disease that its etiologic relation has been discussed. The writers, how-



FIG. 231.

ever, have been able to discover no essential causative connection and are inclined to believe it more the result of the same disturb-

ance of metabolism which brings about the over-deposition of calcium in the bones.

In the X-ray plates the outline of the calcified arteries can often be seen in fine detail.

Not infrequently hypertrophic arthritis accompanies osteitis deformans, but here again the relation is not constant and apparently of no significance.

#### PATHOLOGY

The pathology of osteitis deformans resembles in many ways osteo-sarcoma, and the frequency with which this malignant lesion occurs in bones affected by Paget's Disease makes its occurrence seem more than a coincidence. It is usually of the myelogenous variety and the radiating appearance of the neoplasm is well shown in the X-ray plate.

#### DIAGNOSIS

As has been above suggested, the diagnosis of a well-marked case showing characteristic deformities can hardly be mistaken. The earlier cases, however, showing externally few or no signs of the pathologic process, present great difficulty, and were it not for the X-ray, might well continue to be diagnosed as "rheumatism," syphilis, osteomyelitis, bone neoplasm, etc.

We feel strongly, in light of past experience, that in an adult any indefinite bone pain and any evidence of bony enlargement, the nature of which is not at once apparent on examination, should be investigated by means of a skiagraph. If this is done, fewer cases will be kept on Potassium Iodide, harassed by the belief that they are suffering from a loathsome disease, the origin of which they cannot imagine, and fewer digestions will be perhaps permanently impaired by long dosage with the Salicylates, which temporarily lessen the pain and seemingly prove the diagnosis of rheumatism to have been correct.

The study of a single X-ray plate of this bony change will make easy future interpretations of skiagraphs, for the appearances are

so characteristic as to make failure to recognize the lesion difficult indeed.

The bone has a striated appearance, showing lamellated struc-



FIG. 232. The lesions are often manifested early in the metacarpal bones, as they were in this case. Note especially the third metacarpal on the right hand, and the second and third phalanges on both the right and left hands. The lesions in the radius and ulna are older.

ture and thickening of the trabeculae. The cortex is usually, in places or throughout the shaft, increased in breadth on one or both sides.

Throughout this abnormal bone, where the structure is clearly seen in the plate, will often be found areas of rarefaction, appearing sometimes as definite cavities. Deposit of lime salts beneath the periosteum is also often evident, looking not unlike the same deposition in lues. (Figure 232.)

#### TREATMENT

Discontinuing the administration of the Iodides, with which so many of the patients have been dosed, or cutting off the Salicylates, from which an equal number have been suffering digestive disorders, will frequently produce a change for the better most gratifying to patient and physician.

The institution of a tonic régime often so improves the general condition that one is tempted to believe the disease arrested, if not actually overcome.

Hot applications, and the measures usually calculated to relieve pain, temporarily diminish to some extent the local discomfort.

When the acutely sensitive areas, above referred to, occur, superficial application of the actual cautery over the region of the swelling and along the shaft of the bone have afforded much relief and seem to have favorably influenced the subsidence of the acute process.

Rest and protection for the joint strains overcome their discomfort.

One of our observed cases suffered a fracture of the affected thigh from a severe trauma. The broken bone healed with apparently normal rapidity and firmness. This fortunate circumstance seems to warrant osteotomies for correction of considerable but slowly developing deformities, especially of the lower limbs. The betterment of locomotion would be unquestioned, and although the writers have had thus far no opportunity to perform this operation in Paget's Disease, it will be advised in a suitable case without much anxiety as to the favorable outcome.

## PROGNOSIS

The disease, in spite of treatment, has progressed in all the subjects observed, much more rapidly, however, in some than in others. Pain is frequently an unimportant factor, and except in those cases developing sarcomata, which may be said to be consequent upon the osteitis deformans, intercurrent diseases usually cause death.

The circulatory disturbances dependent upon the commonly accompanying arteriosclerosis are not an infrequent factor in the fatal issue.

While the disease has thus far proved intractable to cure, the outlook for the patient is not hopeless or alarming, and the average length of life may not be materially curtailed.

## CHAPTER VII

### THE PELVIC ARTICULATIONS

WE shall consider these special articulations in more detail than has been deemed necessary with the other joints, largely because our knowledge of their anatomy and mechanism has been only recently acquired. For this reason therefore a proper interpretation of the symptoms resulting from any abnormality in them, together with a just appreciation of the problems of treatment, is not only possible, but of special interest.

In the first place it has been clearly shown that the pelvic articulations are true joints, having all the structures peculiar to a joint, and that in a state of health motion is a definite part of their normal function. The articulations between the sacrum and ilia are by far the most important, and although at times the movement of the symphysis is the more apparent, this cannot take place unless at the same time there is motion at the synchondroses. The study of the sacro-iliac joints makes this at once comprehensible. From the size and character of the sacral joint surfaces, motion at the pubis must be dependent upon the mobility of the sacro-iliac joints (Figures 233 and 234), while much motion or anything like real separation of the pubic bones can be possible only when the relaxation of the sacro-iliac articulations is quite marked. The pubic bones, together with the symphysis, are of comparatively little importance in maintaining the stability of the pelvis, and serve chiefly as an attachment for muscles and a support for the pelvic viscera. As an evidence of this there are many instances in which there is an entire absence of this portion of the pelvic girdle, without serious inconvenience, there even being two cases on record in which pregnancy occurred without peculiar phenomena.

The motion which is normally possible in the pelvic articulations

consists of an up and down play at the symphysis and in the forward and back or tilting movement of the sacrum upon the ilia (or the ilia upon the sacrum), the centre of motion being a transverse axis situated at about the middle of the sacrum. Recognizing this as the centre, it is evident that if the sacrum moves backward upon the ilia at the upper part, or at the brim of the pelvis, the lower part of the sacrum, or the portion at the outlet of the pelvis, must move forward. In this motion, because of the obliquity in two directions of the plane of the articulation between these bones, not only is the sacrum carried backward at the top, thus increasing

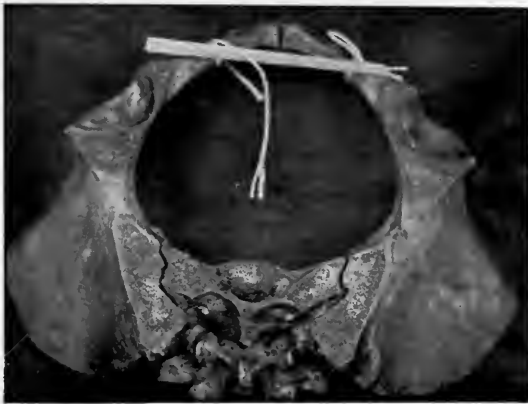


FIG. 233. Sacro-iliac articulations, with bones in place.

the antero-posterior diameter of the pelvis at the brim, but also the ilia are spread laterally, so that the lateral diameter is increased as well. As, however, all of these motions are made upon the transverse axis through the middle of the sacrum, it is necessary for the bones to move in such a way that as the diameters at the brim of the pelvis are enlarged, the diameters, both antero-posterior and lateral, at the lower portion, or the outlet of the pelvis, are at the same time reduced.

The converse is also true if the motion is reversed. If the upper portion of the sacrum moves forward upon the ilia, the lower portion must at the same time move backward.

The fact that the pelvic diameters can be modified by motion of

the bones making up the pelvis is of course of chief interest from the point of view of the obstetrician, but the fact that there is motion and that it is essential has real significance, no matter from what point of view the subject is approached. It is also important (irrespective of the mode of approach) for us to remember the fact that while there is greater mobility of these joints in women, motion is also present in men, and that, irrespective of age or sex, mobility exists in all three of these articulations, unless it be restricted or obliterated as the result of some congenital or pathologic condition.

In connection with the consideration of this subject we should not lose sight of the effect produced upon these articulations in women by the physiological functions peculiar to the sex. In pregnancy the joints are relaxed physiologically, so that the amount of motion at that time is increased beyond normal limits, and while under ordinary conditions this increase is definitely measurable, at certain times it is so very marked that much disability results. Not only does this condition occur during pregnancy, but it is also true that to a less degree a similar condition takes place at each menstrual period, which from a physiological point of view represents a miniature pregnancy. Under these conditions the relaxation is of course slight in comparison with that of pregnancy, but it is at times definite enough to cause considerable suffering and real disability.

Not only do the above conditions exist, but it is probable that we shall find after the study of a considerable number of cases in conjunction with the gynæcologists that in any disease of the pelvic organs in which there is much circulatory disturbance the joints become relaxed, as a part of the same physiological reflex noted in pregnancy and menstruation. While this is probably true, the converse is certainly true, — namely, that if the pelvic joints become relaxed as the result of accident or disease, the lack of stability of the pelvic girdle, with the resulting weakening of the support of the pelvic organs, leads to congestive disturbances in these organs, this in turn probably reacting upon the joints, so that



until the proper treatment can be instituted there exists a vicious circle of cause and effect.

When once it is recognized in the consideration of the pelvic articulations that we are dealing with true joints, we must recognize that they are susceptible to the same diseases as are the other joints. That a tuberculous process may be present has long been recognized, but it is also true that any of the non-tubercular infections, the atrophic type, the hypertrophic type, or malignant disease, may be present, the symptoms undergoing modification as the pathology varies.



FIG. 234. Sacro-iliac articulations, with the sacrum slightly tilted, showing the separation of the ilia at the symphysis pubis as well as at the back.

These articulations are not only susceptible to disease, but because of their character they are more liable to injury than most of the other joints. The bones are simply apposed, with the axis of the joint either perpendicular at the symphysis, or oblique with comparatively little departure from the perpendicular at the sacro-iliac. The bone surfaces are smooth or slightly irregular, so that the stability of the joint depends almost entirely upon the ligaments and muscles. This being the case, anything that leads to loss in the muscle or ligamentous tone renders these joints more prone to strain, and as their stability depends upon soft structures, disturbances in the normal approximation of the bones must be more common and result from much less violence than in the other joints.

The simplest type of trouble consists of the strains of the sacro-iliac joints which result from long stooping, standing, lying, or sitting. In stooping, the muscles at first protect the joints, but as they tire, the support is then thrown upon the ligaments, and if continued leads to so much strain that on straightening, there is a distinct sensation of discomfort referred to the sacral region. This is usually instinctively relieved by stretching, in the act of which the lumbar spine is drawn forward or hyperextended, and the sacrum, moving with the spine, is drawn into its normal position, the sag being corrected and the strain relieved.

In long standing, a joint strain is similarly produced, except that the direction of the strain is downward, and is relieved more readily by change to a position in which different sets of muscles are used.

On lying upon the back, the spinal muscles tire, and as they relax, the lumbar spine sags until it finds support, for example, from the bed. With this backward movement of the spine, the upper part of the sacrum is drawn backward also. If this position is continued for any length of time the drag upon the ligaments may result in a decided strain, accompanied by ache. This condition is naturally seen most markedly where, as the result of the large size of the buttocks or other physical peculiarities, the amount of depression of the spine and consequent drag upon the sacro-iliac ligaments is greater than the average. It is also more marked when for any reason the muscles are more completely eliminated as a factor in the support than is usual with simple recumbency. In this way the common post-operative backache is to be explained. Complete relaxation of the muscles during anæsthesia allows the maximum amount of sag. At such times moreover the patient usually lies upon a hard, unyielding table without opportunity for the buttocks to settle into it as they do into a mattress. It is also in this way that the troublesome backaches occurring in connection with various sicknesses may be explained. In such cases the general disease relaxes the muscles more than normally and at the same time the dorsal position is often long maintained. Both of these conditions are conducive to the strain of these joints.

A similar condition of strain results from long sitting, especially if the body is not held reasonably erect. The common lounging attitude in sitting, if continued, results in strain entirely similar to that seen in recumbency, and explains the backache so often brought on by such attitudes. This feature is very often noticed after long car journeys, the common car seat predisposing to such attitudes, while the few opportunities for marked change of position still further assist in favoring this strain.

In all of the positions which have been described the symptoms are due simply to strain put upon the joint structures. No actual



FIG. 235. Articulated pelvis with the sacrum tilted backward at the top the normal amount, showing the exposed edge of the iliac portion of the articulation over which the lumbo-sacral cord passes.

injury has taken place, and as soon as the position producing the strain is corrected the symptoms disappear. If however the position of strain is continued, the ligaments either give way, allowing the bones to become misplaced or to become relaxed, producing instability of the joints, with or without actual misplacement of bones, and a sense of weakness on use.

Of these two types, the first is most often seen in the so-called "stitch" or "crick" in the back, coming on after long stooping or standing in some awkward position, or in lifting or straining, especially where the load is suddenly increased. Under these conditions, the sharp, sudden pain, usually referred to the lower part

of the back and frequently definitely to one of the sacro-iliac articulations, is due to a rupture of some of the sacro-iliac ligaments, and as this allows a greater range of motion than is normal, a partial



FIG. 236. Observe the "flat back" in this case.

luxation may result. In this there is of course very rarely an entire separation of the opposing articular surfaces, a complete dislocation, but the bones slip enough so that their normal relation is disturbed, with a corresponding disturbance in the normal function of the part. Frequently this condition is corrected simply by the muscular effort of assuming the erect position, but at other times the irregularities which form the surface of the articulation are caught on opposing irregularities and voluntary correction becomes impossible.

This of course impairs the normal function of the joint, and because of the character of the articulations in the pelvic girdle, it is evident that if one joint is injured each of the other joints must be somewhat strained, so that the disability resulting from even a slight luxation of one of the

sacro-iliac joints may become very great. This disability is in part due to the fact that as both the thigh and the trunk muscles are attached to the pelvic bones anything which disturbs the stability

of the pelvis must interfere with the action of these muscles, and in this way the inability to do such things as raising the body from the stooping posture can be understood.

Under such circumstances not only are the joint structures injured or strained, but the large nerve trunks which cross this articulation in front are frequently irritated. Anatomically the sacral plexus of nerves with some of the branches from the lumbar plexus cross just in front of the synchondroses. (Figure 235.) This being the case, it is not difficult to understand the fact that irritation of these nerves is possible. The symptoms resulting from such irritation naturally vary, depending upon the special nerve irritated and the extent to which this takes place, but it must be remembered that pain or disturbed sensation will be referred to the distribution of the nerve irri-

tated and not to the seat of the injury. In this way the so-called referred pains and the areas of anæsthesia or hyperæsthesia are to be explained. As the nerves most liable to irritation are distributed to the lower leg and the back of the thigh, it is easy to understand the cause of many of the cases of so-called sciatica and the hopelessness of treatment applied to the seat of the pain.

The displacement most often seen is a backward dislocation of the upper portion of the sacrum upon the ilia. In acute injuries



FIG. 237. Note the sharp lateral deviation of the column to the left.

or diseased conditions this is usually noted upon one side only, while with the chronic sprains or the cases in which there is longstanding relaxation the displacement is usually upon both sides, resulting in the flat back, as seen in Figure 236. With the acute

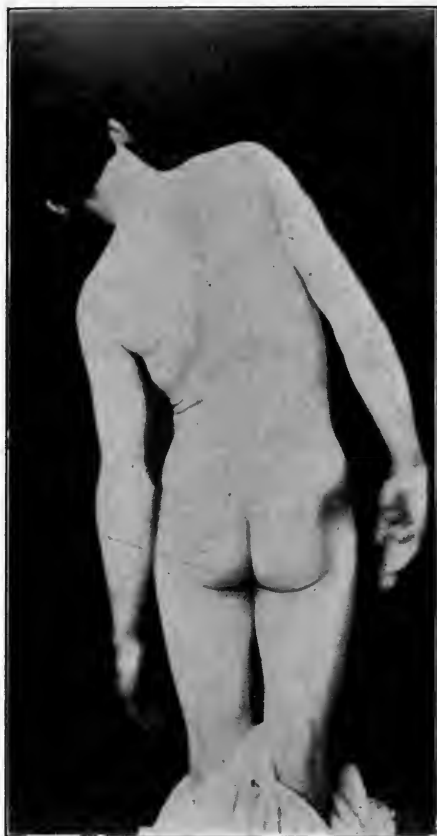


FIG. 238. Showing limitation of motion.

cases, while the usual displacement is of the sacrum backward, the reverse of this is possible, the upper part of the sacrum being drawn forward upon the ilium. It is also probable that in rare instances, especially as the result of falls, the sacrum is forced downward, so that the ilium is made to appear actually higher, with apparent shortening of the leg. It is in these cases of injury or of disease upon one side that lateral deviations of the trunk (Figures 237 and 238) are seen. It is also in these one-sided lesions that referred pains are met most frequently. In chronic relaxations apparently the changes take place so slowly that the nerve trunks be-

come adjusted to the changes, and consequently referred pains are not as common. With acute conditions the changes are produced so rapidly that much irritation results. The unilateral displacements are likely to be more severe than the bilateral and the symptoms of nerve irritation are therefore often more acute in the unilateral than in the bilateral cases. The displacement of

the bones which results in this nerve irritation may be produced by disease of the joints. In either case the pain may vary from slight twinges to the most intense suffering. If the irritation is continued for any length of time the muscles supplied by these nerves become atrophied, a fact which frequently shows by measurement, but which is very noticeable to touch.

Thus far the conditions which have been considered have resulted chiefly from injury or strain, and while this is the lesion commonly encountered, owing to the character of the articulations, it is to be remembered that definite diseased conditions may have the same etiological importance which they possess in other joints. It is also true that the joint weakness which results from common injuries or long-continued strains predisposes to disease which probably



FIG. 238a. Note the greater freedom of motion toward the patient's right.

would not develop otherwise. This is true of any of the infectious processes, either tuberculous or non-tuberculous, and it is certainly true that continued strain or injury leads to the development of the hypertrophic type of chronic non-tuberculous joint disease (osteoarthritis), which in many instances results in the complete ankylosis of these joints. (Figures 239 and 240.)

Of the special diseases which may be met with in the pelvic articulations, the most common are undoubtedly the infectious processes. Of these the tuberculous is less frequently seen than the non-tuberculous. Of the non-tuberculous infections, any one of a large number of organisms may apparently produce the local condition, and the special joint lesion may be part of a polyarticular process,



FIG. 239. Hypertrophic arthritis, showing the fusion of one sacro-iliac articulation, the other (the left) being freely moveable.

or it may be confined entirely to one of these joints. The course of the disease in the given case depends upon the particular organism present and upon the degree of its virulence. The symptoms may be mild, with no ultimate impairment of joint function, or they may be very severe, with actual bony destruction, much suffering, and great disability. The treatment of the given case will also depend upon the nature of the organism and its virulence, and should be planned in keeping with the principles mentioned in the chapter upon Infectious Arthritis. The tuberculous process is of course also an infection, and should be treated as any other infectious joint process, always remembering that with tuberculosis, while the process does not always result in bone destruction, this never-



theless is the tendency, and protection of the joint should be planned accordingly.

An infectious process or any injury or continued strain may result in the development of a hypertrophic process. In this, the edges of the articular cartilages become thickened, leading to an increase of irritation and consequently a continuance of symptoms.



FIG. 240. Hypertrophic arthritis of spine and sacro-iliac articulations, with fusion of both of these pelvic joints.

If this condition is recognized early and the joint protected so that the irritation is eliminated, the disease ceases and recovery follows, with little if anything to indicate its former presence.

Of the other bone diseases, osteomyelitis occasionally attacks the ilium and extends to the sacro-iliac joints. Malignant diseases may also invade these articulations, and because the pelvic organs are so frequently the seat of neoplasms the possibility of extension of such processes to the bones and joints of the pelvis must be borne in mind. Sarcomata have been seen by the writers in these joints in several instances, while carcinomata have been noted only once.

#### SYMPTOMS

The symptoms upon which a diagnosis of disease or weakness of the pelvic joints is to be based vary considerably, but certain

features are practically always present, and if properly interpreted should make the condition plain. The most common symptom is the peculiarly characteristic limitation of motion in the spine as described above, and this of itself is usually enough to establish the diagnosis.

**Pain.** Pain is quite constant, and is localized at the seat of disease, either in the sacro-iliac joints or in the sacral region, or is referred to the legs and feet because of irritation of the nerve trunks. The referred pains may extend the length of the leg, usually on the posterior surface, or may be referred to definite areas in the upper or lower leg or to the foot. The pains are definitely increased by those motions which result in strain of the affected joints, but are not ordinarily increased by pressure along the course of the nerve as they would be with a true neuritis. The pain is almost always worse at night because of the strain put upon the pelvic joints at that time, but is relieved by such changes of position as tend to overcome the strain, and is prevented by postures in which this strain is entirely eliminated. Pain is present during the day only when the pelvic joints are used and strained,—for example, in long sitting or stair-climbing,—and is usually much worse in one leg, though it may be present in both. When present in both, great care should be taken to exclude new growths in the spinal canal.

The local pain, when present, may be referred definitely to the sacro-iliac joints, but more often to the sacral region, and in women is worse at the menstrual period because of the relaxation of the joints at that time. Rectal examination is at times helpful in making the diagnosis, as by this means tenderness along the affected joint may be noted.

With children pain usually takes the form of leg-ache or back-ache, rarely being acute, and while it may be present during the day and interfere with the normal activities, it is almost always worse at night, sometimes awakening the child with a “night cry” similar to that heard in children having hip-joint disease. “Growing pains,” which are of such frequent occurrence and represent so often the beginnings of coxitis, should be investigated.

**Swelling.** At times, usually in connection with infectious processes, the sacro-iliac joints are enlarged so that the swelling is visible or can be palpated. The character of the swelling will depend upon the nature of the lesion. If tuberculous, there is usually considerable infiltration of the tissues, often without definite fluctuation unless the process is so far advanced as to result in abscess formation. Associated with this there is considerable atrophy of the buttock, and this, with the history of a slow onset, is usually sufficient to make the nature of the process clear. With non-tuberculous infections there is also infiltration and there can sometimes be made out a sense of fluctuation. The muscular atrophy is slight, and this, together with the more acute onset and the not infrequent involvement of other joints, should make differentiation possible.

**Abnormal mobility.** In lesions of the pelvic joints there is almost invariably limitation of some of the active spinal motions. There is however in certain cases an increase of the passive motion of the sacro-iliac joints. This increase will be seen chiefly in the cases in which as the result of long-continued strain these joints have become relaxed. To determine this various tests may be made. Forced hyperextension of the thighs, one at a time, with the hand placed over the articulation, may be sufficient to demonstrate this hypermobility. At other times, with the patient standing, if one hand is placed over the sacrum while the pubic bones are held between the thumb and finger of the other hand, and the patient first raises one knee and then the other, motion is often quite distinct. If the crests of the ilia are grasped with the two hands, the thumbs resting upon the sacrum, and the patient raises the legs as above, mobility is also often apparent.

**Attitudes in standing or walking.** Disease or weakness of the sacro-iliac joints results in peculiarities in the use of the body that are suggestive. When standing, the trunk is usually inclined away from the joint chiefly affected. In rising, the spine is generally held rigid and the hands are frequently used for support, as in tuberculosis of the spine. In stooping, flexion of the trunk is avoided.

In walking, the motions are made guardedly if the condition is at all acute, or if the joints are much relaxed the gait is rolling or even waddling as the result of pelvic instability. If the condition is acute, a long step in walking is impossible, owing to the spasm of the hamstring muscles, which as the leg is straightened jerk the thigh backward.

**Limitation of motion.** In any event, if the sacro-iliac joints are strained or diseased the motion of the body which causes strain of these joints is limited involuntarily, as is seen in the diseases of the hip, knee, or other articulations. With the sacro-iliac joints, the limitation may show by motions of the body upon the thighs or by the motions of the thighs upon the body. Forward bending of the trunk with the knees straight will be limited if the lesion is one of any magnitude, because the hamstring muscles are made tense and strain of the sacro-iliac joints must result.

To prevent this strain the spinal muscles contract reflexly and normal motions are restricted. To determine whether this limitation of motion is due to disease of the spine or of the sacro-iliac joints, the knees should be flexed, the patient being allowed to sit, and in this position the same motion tried. If the spine is involved the limitation will be present as in standing. If however the trouble is in the sacro-iliac joints the bending will be much more free, since with the hamstring muscles relaxed, as they are when the knees are flexed, forward bending is performed almost entirely with the spine and the hips, the sacro-iliac joints being used only in the extremes of motion.

While forward bending is limited when the patient is standing, lateral bending may be also limited, and as one side is usually more affected than the other, the bending to one side is generally more free than to the other (Figure 238), and not only is it more free but it is made with different segments of the spine. While with forward bending the change from standing to sitting makes a very noticeable difference in the motions, in lateral bending this difference is not as marked, since in this the hamstring muscles play but little part.

In backward bending the motions are usually guarded, and in the extreme cases it may be impossible to assume the erect positions.

In all of these motions the thighs are made the fixed point, the body moving upon them, and not only this, but the tests are made with the joints carrying the body weight. The same motions can be tested without this latter feature being present if the patient is made to lie down and the thighs are held fixed. In this way with the patient upon the back, forward bending can be tested, and when lying upon the face the amount of backward or lateral bending may be determined.

After these tests have been made the leg motions should be tried, the body, under these circumstances, becoming the fixed point. The hip and knee motions should be free unless they produce strain of the sacro-iliac joints. With the knee bent, the hip motions are free and without pain except when the disease or lesion of the joint is very acute, at which times the extremes of motion, especially outward rotation with abduction, may be associated with pain referred to the sacro-iliac joints.

In making these tests, while the hip motions are free as long as the leg is flexed, if the leg be straightened and then flexion of the thighs be attempted, limitation will be definite. Since the hamstring muscles are attached to the ischium, it is seen that tension upon these muscles must result in strain to the sacro-iliac joints. Of the various tests made to determine the condition of these joints, this one, that of flexing the extended leg upon the body, is the most reliable. In any case in which there is definite disease or acute strain of the sacro-iliac joints, the straight leg-raising will be limited, probably passively and certainly actively, and not only is the motion limited but attempt to carry it farther may produce pain referred directly to the sacral region. In applying this, König's test for sciatica, which is so constant that it can almost be called as well the "sacro-iliac joint test," whenever there is trouble in one joint, the straight leg-raising upon that side will be limited, and also a similar limitation with the other leg may be found, although not as marked. This

limitation upon the opposite side is to be explained by the fact that in the motion made with the hamstring muscles tight the ilium on that side is moved, and the sacrum naturally moving with it, the affected joint is strained. Not only is this limitation of motion present on the side away from the lesion, but the pain which is developed by the motion is referred to the seat of the disease or to the leg on the side affected, and whether one leg or the other is raised the pain is referred to the side of the lesion. These tests, which should at first be made passively, will be even more striking if attempted actively by the patient.

### TREATMENT

The treatment of these conditions consists essentially in the protection of the joints, after previous replacement of the bones should luxations exist. In the severe cases complete immobilization with relief from all strain is necessary, while in the mild cases restriction of motion or lessening of strain may be all that is required. In tuberculous disease, osteomyelitis, and occasionally neoplasms, it is sometimes necessary to remove portions of the diseased bone, but with these exceptions cutting operations are not apparently required in pelvic joint lesions. In planning the treatment it is to be remembered that the involvement of the symphysis pubis, with the exception of a few very rare inflammatory conditions, is to be considered as secondary to relaxation or disease of the sacro-iliac articulations, and the treatment for the anterior joint is distinctly secondary to the treatment of the posterior joints.

The treatment of the given case depends of course upon the extent of the lesion and its pathology. If, as is seen frequently in the traumatic or relaxed cases, the bones are not in correct position, they must, if possible, be brought into proper relation with one another.

The correction of the subluxation may be brought about in several ways. At times simply hyperextending the spine considerably by having the patient lie with a firm pillow under the "hollow of the back," may, by raising the lumbar spine, draw the sacrum

into place. At other times the same thing may be accomplished by causing the patient to lie face downward with the thighs and legs supported upon one table, the head and shoulders upon another, the body hanging entirely unsupported between. In this position the weight of the body drags the spine forward, thus favoring the replacement of the sacrum. If this is successful, a plaster jacket designed to hold the spine and the pelvic joints may be applied before the patient is moved.

At times more definite pressure directly upon the sacrum is apparently needed, and for this the frame (Figure 241) which is in use for the application of plaster of Paris jackets in cases of tuberculous disease of the spine is admirably adapted. In using this the flexible rod *a* should be bent with a sharp curve low down, so that the greatest pressure is upon the upper part of the sacrum and the low lumbar spine. In this position the weight of the body tends to force the sacrum forward, with usually sudden and marked relief as the bones slip into place. While in this position the plaster of Paris jacket should be applied, the steels being incorporated and removed when the jacket is thoroughly hard.

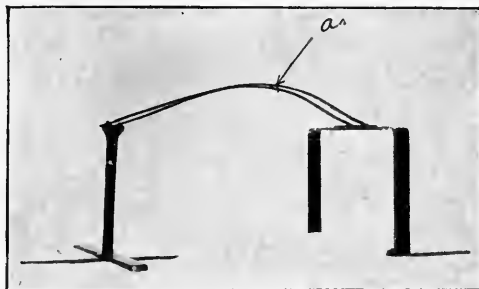


FIG. 241. The arrow indicates the point of application of the greatest pressure upon the upper part of the sacrum and the low lumbar spine.

If these procedures are not successful an attempt should be made to manipulate the ilium upon the sacrum and thus effect the replacement. For this, the patient should lie upon the side and with one hand gripping the ischium while the other holds the iliac crest, the bone is moved upon the sacrum either forward at the top or backward at the bottom, depending upon the character of the luxation.

In case none of these methods are successful an anæsthetic

should be used, so that the muscular relaxation is complete, and in this state an attempt to overcome the difficulty should be made. For this either of the above procedures may be used, or what is better, the thigh may first be flexed with the leg extended to at least a right angle with the straight line of the body, and if the sacrum has slipped backward this manipulation will result in slipping the ilium backward upon the sacrum and consequently into its proper place. If the position of the bones is reversed the patient should lie upon the face or side, and by using the thigh as a lever, drawing backward and at the same time pressing forward over the sacrum, the misplacement will be overcome. As in the forcible manipulation of other joints the best results will follow if the motion is first made as if to increase the deformity; resisting adhesions are thus broken up and subsequent replacement rendered more easy.

After the bones are once in place in these cases, they should be held there by means of some fixed support, and for this purpose the plaster of Paris jacket is probably the best. This should be fitted well down over the buttocks and the anterior part of the thigh, so that the pelvic bones are really held. At the top the jacket should be carried well up the thorax in order to hold the spine hyperextended, at the same time preventing the lower part of the jacket from riding up and releasing its hold upon the pelvis.

If the bones cannot be held by the jacket alone the plaster dressing should be carried down the thigh, making a spica bandage, and in the extreme cases including both thighs. During this period the patient should naturally be kept in bed.

If the case is one of recent injury the principles of treatment are the same as those applicable to sprain of any of the other joints, except that because of the shape of the pelvic articular surfaces, the period of complete fixation must be longer. Fixation is necessary for three or four weeks. Whether the patient remain in bed or be allowed up in a jacket must be determined by the symptoms. After this a removeable jacket or some form of support should be worn for two or three months, considerable attention being paid during



the latter part of the period to exercises and massage in order that the muscles may be of sufficient strength when the supports are removed.

If the case be one of extreme relaxation of the ligaments, recumbency in a jacket or some equivalent support may be necessary. This is particularly apt to be needed in stout women in whom it is hard to adequately support the bones when they are permitted to walk about.

The majority of cases however do not need actual recumbency. In the joint strains or the relaxations without displacement of the bones which represent the large proportion of the total number of the cases, some form of support is usually sufficient, and frequently there need be little interruption in the usual routine of life.

Of the various devices which have been employed to relieve the strain upon these joints, without question the plaster of Paris or the stiffened leather jackets are the most satisfactory in the severe cases, although in very stout patients accurate pressure upon the pelvic bones is difficult to obtain. If a jacket



FIG. 242. These are made of heavy silk elastic. They are very useful in the convalescent cases and for night support.

is used it should be fitted well down over the trochanters, so that the pelvis is really held. Ordinarily the best position for the application of the jacket is with the patient standing, with the arms raised about shoulder-high, the hands grasping some support, the lumbar spine being at the same time moderately hyperextended.

In women a wide webbing belt attached to the base of the corsets, and kept from wrinkling by the insertion of light steels, often gives the desired support. In men the same principle can be used by

means of a belt or a low corset made of webbing. Such belts can at times be made more efficacious by attaching a firm pad in the back so as to make pressure over the upper part of the sacrum.

In many of the cases much relief is obtained by wearing woven elastic trunks, fitted about each thigh, and also about the buttocks. (Figure 242.) These are laced or buckled, so that the pressure may be controlled, and represent one of the most reliable of the various supports.

Another support, and one which is admirable in the severe cases, is the brace pictured in Figures 243 and 244. It consists of a sacral



FIG. 243.

pad, to which a spring-steel crib is attached. The ends of the crib curve backward, and to these webbing belts are attached, which, when fastened in front, because of the curve in the crib part of the brace, crowd the sacral pad firmly against the upper half of the sacrum. The brace is kept in place by attaching it to the corsets by means of steels, as shown in the figure, and these not only hold the brace down, but

by steadying the lumbar spine, at the same time lessen the tendency to strain of the sacro-iliac joints. In order to keep the brace in place when sitting a narrow belt is attached to the base of the crib, which is tightened when the thighs are flexed and prevents the brace from springing away from the body. This brace, in connection with the elastic trunks in the more intractable cases, has given relief when either alone was not satisfactory.

In the mild cases, or as an adjunct to the various forms of apparatus in the severe cases, strapping of the back with adhesive plaster gives much relief. For this the strips should extend from the anterior part of the ilium on one side to a corresponding point upon

the other side, and these should be carried up and down until the buttock and the lower part of the lumbar spine are covered. The dressing at times is more satisfactory if a pad of felt is put under it to make pressure over the sacrum. If such a dressing is used it should be reapplied after six or seven days.

In planning relief for these patients it is to be remembered that some form of support for the bones during recumbency is of quite as much importance as that for ambulatory use, the night pain being often the most severe. For this purpose a firm pillow under the hollow of the back is frequently sufficient, and this should be used under the side if the position is changed. The strain upon the back is also lessened by using a small pillow under the knees because of the relaxing effect upon the hamstring muscles.

At other times the elastic webbing trunks give sufficient relief for night support, while in some of the extreme cases plaster of Paris moulds, fitted so that the back, sacrum, buttocks, and thighs are all supported, are used.

Considering the fact that in women subluxation of the joints has been so often associated with congestion of the pelvic organs, such as menstruation and pregnancy, it is advisable in cases in which a definite pathological condition of the pelvic organs exists that this should be treated before treatment of the joint lesion is begun.

**Visceral support.** The importance of the stability of these pelvic joints in connection with the proper support of the abdominal and

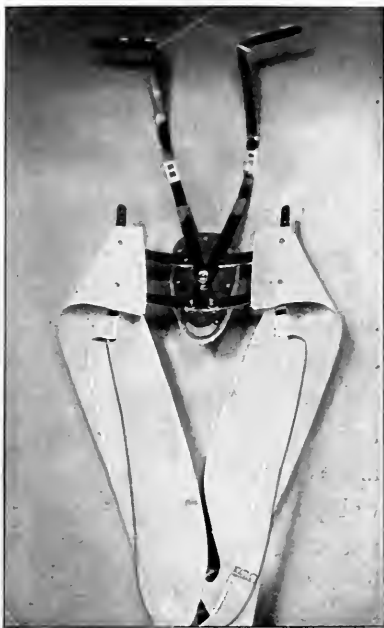


FIG. 244.

pelvic viscera has already been mentioned. It is however the wish of the writers to more definitely emphasize this feature, since an understanding of it suggests the explanation of many conditions about which there has, at least, been uncertainty, and at the same time suggests treatment for the relief of symptoms now not satisfactorily controlled.

The viscera are held in position by ligaments or structures, which, while perhaps not so designated, are nevertheless ligaments in point of practical function, by muscles, and by the direct support which one organ from its bulk or structure may give another. The muscular support is undoubtedly the most important. The tone of the ligaments naturally depends largely upon the tone of the muscles, since that which stimulates one must stimulate the other, and also because that which lessens the muscle tone produces increased strain upon the ligaments, this in turn if continued leading to weakness of the structures strained. In the second place the muscles are of importance not only by furnishing firm abdominal walls, thus preventing the sag of the viscera and leading to the weakness and relaxation of the ligaments, but are of quite as much importance in making it possible to hold the body in such attitudes that there is the least possible tendency to visceral sag with accompanying ligamentous strain. It is evident at once that when the body is erect with the muscles in good tone, and the abdominal walls firm and comparatively flat, the stomach, the liver, the intestines, the kidneys, — in fact, all the viscera, — are causing the minimum amount of sag and producing the minimum amount of ligamentous strain. It is equally evident in the attitudes seen invariably in those who are poorly developed muscularly that there must be an increasing drag upon the ligaments. The mere character of the attitudes, all of which are attitudes of muscle fatigue and in all of which there is the droop of the body forward, the organs sag more and drag forward, pulling directly away from their attachments.

If this is true, especially if at the same time the unsatisfactory results of the ordinary treatment of the loose or misplaced vis-

cera are also considered, then the condition of the general muscle tone becomes of more importance than has been commonly held.

If these conditions are recognized and the stability of the pelvic joints be made at least one object of treatment, there will be fewer patients who are unrelieved even after long and often heroic treatment for loose or misplaced viscera. The joint condition is surely not responsible for all of the cases of visceral displacement and relaxation, with all their psychoneurotic manifestations, but we believe that either condition may lead to the other and that when once started there exists a vicious circle of cause and effect which makes it difficult to relieve unless both are recognized. Joint support and improvement in the muscle tone may not alone overcome the many symptoms present in such cases any more than does surgery alone often relieve such cases, but if the problem is faced from both points of view, unless some actual disease is shown to be present, the relief of this large class of patients is simple and definite, and will not in the future represent the reproach to the profession that it does at the present time.

The length of time required for treatment in a given case depends upon many things. In a wrench or strain with much displacement of the bones, strapping for three or four weeks followed by a corset belt for a few weeks longer may be all that is necessary. If the condition still represents an injury, only a more severe one, the treatment must be kept up for a longer period, the duration and the completeness of the fixation depending upon the severity of the injury. It should always be remembered in such cases that, as the sacrum and ilia are held in place almost entirely by ligaments without bone sockets or other supports, the treatment of lesions in these joints should be continued for a considerably longer time than in other articulations where the ligamentous support is less important.

In the cases in which the symptoms are due to the hypertrophic type of chronic non-tubercular joint disease, tuberculosis, or to inflammatory processes, the condition in these articulations should

be treated in the same manner as like conditions in other joints. Protection should be more complete and recovery is more tardy.

In the relaxed cases associated with pregnancy the patient may be allowed to be about with the support on until three weeks before delivery, and the support should be worn until all symptoms have disappeared.

In some of the relaxed cases associated with menstruation without pregnancy or which are part of a general relaxation it may be necessary to wear some form of support for an indefinite period.

In the cases in which the weakness has been associated with menstruation, or in which the weakness has followed pregnancy and gone on untreated, benefit will result even though another pregnancy should occur, provided the bones are properly supported during that period. The acute congestion of the joints occurring at such a time will tend to stimulate more complete and rapid repair, as congestion does when applied to other articulations.

**Case I.** P. C., 5½ years of age.

The child was brought for examination in 1904 because of pain in the feet and legs, the leg pain being more marked at night, awakening the child, the feet at those times frequently being cold, the pain being relieved by rubbing the legs and back. The child tires easily during the day, and after much play is worse at night.

The boy was in poor general tone, generally loose-jointed, with flat foot, and with distinct weakness and strain of the sacro-iliac joints. The leg pains, commonly described as "growing pains," undoubtedly were due to the pelvic joint strain.

For treatment the flat foot was corrected first, but without relief. Later a brace was applied to support the lower spine and the pelvic joints, with almost instant relief, and later a simple pelvic belt was applied, which was worn for nearly two years, during which time the child's general condition improved so markedly that the belt was not needed, the leg symptoms having disappeared.

The case represents one of relaxed pelvic joints in childhood, resulting in the so-called "growing pains" entirely relieved by the support of the weak joints.

**Case II.** Dr. M., a woman physician, 50 years of age, sought treatment for trouble with the back which had been present off and on since she was a young girl. At times there had been comparatively little difficulty; at other times a great deal of disability. The condition had always been supposed to be muscular rheumatism and

had been treated accordingly. Of late the condition has been markedly worse, so that her occupation has been seriously interfered with.

The pain is always worse when lying down; the nights are very restless. In the morning the pain is particularly bad; the effort of getting up is made with much suffering.

The examination showed a patient in poor general health, standing with the whole body inclined forward, with the lumbar spine flat. The pain was referred definitely to the sacro-iliac articulations; spinal and hip motions, causing strain upon the sacro-iliac joints, distinctly limited, with pain referred to the sacral region. Spinal, hip, and other joint motions are free.

The case represented one of long-continued strain, with relaxation of the sacro-iliac joints, and with functional weakness of the spinal muscles. For treatment the adhesive plaster strapping across the posterior part of the pelvis was applied with almost immediate relief. A belt was fastened to the bottom of the corset to give circular pressure about the pelvis and a light splint was added under the corset to give the correct lumbar curve to the spine.

Six weeks later the patient reported that she has not come for further advice, as the symptoms had been entirely relieved, and for the first time in years she felt well and equal to her work.

The problem in such a case involves the use of the supports for a few months, with proper exercise, and training in the correct use of the body in order to bring about complete recovery.

**Case III.** Miss S., 34 years of age.

The patient has been an invalid for fifteen years, suffering much from sciatica, with backache, and "neuritis" of the right arm.

Seventeen years ago the patient fell over some stairs, striking the lower part of the back, being quite lame with considerable pain referred to the lower back for some time. Two years later she had an acute illness, with a high temperature, which lasted for a few days. After this a severe backache developed with pain in the right leg, supposed to be sciatica, and ever since then patient has had sciatica off and on with continued backache and has been an invalid. The menstrual pain at the period is always increased.

The examination showed a person in very poor general condition with extreme tenderness over the region of the sacrum and especially the sacro-iliac joints. She can stand only with the use of a cane and the assistance of another person, with the body inclined forward, with the lumbar spine flat. Any motion of the lumbar spine or of the thighs which produced motion or strain of the pelvic joints was extremely painful. The straight leg-raising, in which the hamstring muscles are made tight, is painful and limited.

The history suggested weakening of the sacro-iliac joints at the time of the injury, with a relaxation of the joints at the time of the acute illness, and the displacement of the sacrum backward at that

time, the sciatica representing the irritation of the sacral plexus consequent upon the displacement of the bone. The neuritis of the arm was due to the extreme forward position of the shoulder and the crowding of the brachial plexus against the ribs.

The pelvic joints were manipulated under an anæsthetic, the sacrum forced into place with a temporary increase of the sciatic pain. This gradually ceased. There was marked relief almost at once in the general nervous tension, and with the aid of supports, consisting first of the adhesive plaster strapping, later of the pelvic belt and the flexible back brace, the patient was able to get about and has gradually regained her health, with nearly normal return of the body functions. With the change in the posture and the holding back of the shoulder, the arm pain has disappeared.

**Case IV.** A. W., 34 years of age.

The patient sought treatment because of intense pain in the left leg, which had been present off and on for two weeks, appearing after an attack of la grippe and a distinct strain of the back in lifting. For three days the pain had been so intense that the patient had spent most of the time both day and night leaning upon a shelf, the recumbent or the sitting position causing intense suffering.

At the time of the examination the patient was standing with the body markedly listed to the left, inclined forward, and the lumbar spine completely flat, with the axis of the sacrum more nearly vertical than normal. Any attempt at spinal motion or thigh motion in which the hamstring muscles were tense was markedly restricted, causing intense suffering.

The history and appearance suggested a displacement of the sacrum backward at the top, with the resulting limitation of motion, the leg pain being due to the irritation of the sacral plexus.

At the time of the first visit the patient was placed upon the frame used for the application of plaster jackets, the steels being bent so as to force the lumbar spine forward. In this position with the forcing forward of the lumbar spine the sacrum slipped into place, with an immediate disappearance of all pain and the muscle spasm. A jacket was applied in this position. The patient was able to walk to the car without difficulty; a second slipping occurred when the jacket softened and was corrected more thoroughly under an anæsthetic. A leather jacket completed the cure.

The case represents one of recent displacement of the sacrum made possible by the weakness following the attack of grippe and brought about by the wrench.

**Case V.** Mrs. F., 68 years of age.

Patient has complained of weak back for many years, which has so limited her movements as to make her very inactive. The ache is referred to the sacral region, and on standing or much walking, down the back of both legs. The nights are restless, there being con-



siderable pain in certain positions. The examination showed a patient in poor general condition, the abdomen prominent, with considerable lordosis, the shoulders and upper spine drooping forward, the spinal motions free except those which involved the use of the sacro-iliac joints, the hip motions free except the straight leg-raising.

The case represented one of relaxation of the sacro-iliac joints, and for treatment a pelvic belt was applied, giving support about the pelvis, and at the same time overcoming the lordosis, and supporting the abdomen. This yielded almost instant relief, and since then the patient has been able to go about with considerable freedom. She will probably wear the belt permanently.

**Case VI.** Mrs. C., 30 years of age.

The patient, in connection with her second pregnancy, had an extreme relaxation of all her pelvic articulations, with a complete backward dislocation of the sacrum, and such an obstruction to the outlet of the pelvis that it was impossible for skilled obstetricians to save the life of the child in delivery. With mechanical supports the sacrum was forced into place, and with belts and braces the ligaments and muscles regained their tone sufficiently, so that except for occasional pain when greatly fatigued she suffered no inconvenience.

Two years later another child was born, the pregnancy and the recovery afterward being in every way normal. The case is reported as being one of extreme relaxation of the pelvic joints, the relaxation being overcome by appropriate treatment at the time.

**Case VII.** Mr. A., 18 years of age.

The patient is a midshipman at Annapolis and in spite of active treatment has been away from his duties for the past ten months because of severe sciatica in the right leg. The trouble came on suddenly, has persisted, causing much suffering. In that time the patient has had all sorts of treatment, including injections along the nerve sheath, massage, long periods of rest, drugs, etc., with no improvement. The examination showed a patient standing with all muscles of the spine and thighs in marked spasm, the body listed slightly to the left, with forward bending and side bending markedly limited. The spinal motions were much more free if the patient were seated, in which case the hamstring muscles were relaxed. The hip motions were free, except the straight leg-raising, which was almost entirely limited. The lumbar spine was flat and the axis of the sacrum more nearly vertical than normal.

The case represented a backward displacement of the sacrum upon the left side.

At the hospital the pelvic joints were manipulated, but the replacement of the bones was not possible at that time. Plaster jackets and other forms of spinal support were applied without relief. Three weeks later another manipulation was performed, this time with a distinct slip of the bone into place, and immediate relief

of the sciatica. A few days later the patient left the hospital, and on the way across the city the bone slipped slightly out of place with an instant return of the sciatic pain, which was at once corrected by the application of a brace holding the bone in place. Since then with the use of the belt there has been no further difficulty.

**Case VIII.** Miss W., 28 years of age.

The patient was seen four years ago because of severe sciatica, which had been intermittent for four years. In that time she had had much backache, as well, both pains being worse at night. The patient had become very nervous and neurasthenic.

From the attitude assumed in standing and the limited motion, a lesion of the sacro-iliac joint was suspected and fixation apparatus applied, but entirely without relief.

Later manipulation of the sacro-iliac joints under ether resulted in a marked slip of the sacrum into place, with instant relief to the pain, with an immediate ability to go about, with a rapid disappearance of the neurasthenic symptoms and an entire permanent relief. A belt was worn for a few months following the manipulation.

**Case IX.** Mrs. H., 40 years of age.

The patient sought treatment because of severe backache. There had been three pregnancies, with the last two much debility, great difficulty in moving about, and much backache, especially during the latter part of the pregnancy, the pain being referred definitely to the symphysis. Following the birth of the last child, the patient was confined to bed for three months.

The examination showed distinct relaxation with abnormal mobility in the sacro-iliac joints, and marked weakness of the spinal muscles. With mechanical supports and exercises the patient entirely recovered, and two years later went through another pregnancy without difficulty, except that during the latter part it was necessary for her to wear adhesive plaster strapping applied across the lower back to relieve the pain which developed at that time. With this the pain and disability were entirely controlled. The patient recovered from the pregnancy, getting up in three weeks and with the temporary use of a pelvic belt for a few weeks has remained well since.

**Case X.** Mrs. T., 33 years of age.

The patient complained of pain in the back, feet and legs, aggravated by standing, worse at night, and always worse at the menstrual period. The back pain was referred definitely to the sacral region. The sacro-iliac joints were shown to be strained.

The adhesive plaster strapping applied to the lower back gave instant relief. At this time a train of symptoms was reported, due to the abnormal mobility of the kidney, a condition which had been so marked that her general physician had felt that an operation to suture the kidney in place would be necessary. Appreciating the

effect of poise in connection with the support of the kidney and appreciating the effect of poise in the cure of the pelvic joint condition, the operation was temporarily deferred, the supports applied to correct the body poise, the belt continued for the pelvis, with a marked relief of the pelvic joint symptoms, and with at the same time an entire cessation of kidney symptoms, so that now for four months the patient has had no return of the kidney pain which was almost constant before and is considered well of this condition by her family physician. The case represents one of pelvic joint strain, with imperfect poise, with the sag of the kidney largely dependent upon the poise, with the correction of both by the restoration of the poise and the temporary use of the pelvic supports.

**Case XI.** Mr. T. C., teamster, 33 years of age.

Exact time when first "catch" in low back occurred not known. Entered Hospital for ether manipulation because of pain, list and other marked symptoms of left sacro-iliac displacement. First manipulation accompanied by scraping

sound relieved pain for two months, then recurrence of symptom unrelieved by second manipulation and protection of joints.

Arthrodesis of left sacro-iliac joint was performed. Uneventful convalescence. Entire relief with resumption of old occupation in about two months. At the end of one year, result seems permanent.



FIG. 245. Arthrodesis of the sacro-iliac joint. Photograph taken eight weeks after operation. The scar of the operation is faintly shown. The dimple at the top represents the location of a wick used for a few days after operation. The skin incision was prolonged unnecessarily far down on the buttock. At the time this was taken there was no list of the trunk, and spinal motions were equal on the two sides and nearly normal. (Case XI.)

## CHAPTER VIII

### VILLOUS ARTHRITIS

CHRONIC villous arthritis is scarcely distinguishable from chronic infectious polyarthritis. There are doubtless some types of this trouble which are not dependent upon demonstrably infectious lesions. They may be the result of external traumatism or they may be caused by disturbances in the static conditions of the body, as in the more extreme grades of valgus and weak foot. Schüller, to whom reference has been made elsewhere, believes there is a specific organism which is constantly associated with this condition. The writers are unable to concur in this opinion because of their clinical experience and the evidence obtained by bacteriologic investigation. Neither the gross pathology nor the clinical appearances of these cases of chronic villous arthritis can alone supply the evidence which will enable one to say that in a given instance syphilis, infectious polyarthritis, the atrophic type of chronic joint disease, or traumatism either within or without the joint, may not be the cause of the villous hypertrophy.

In the chapter on Lipomata reference has been made to the arborescent type of villous hypertrophy. Occasionally this change is confined to such large articulations as the knees, but much more frequently a greater number of joints are involved. The joints are swollen quite symmetrically; motion may be wholly free, or restricted slightly at the extremities of the normal arcs. The catching and pinching of these fringes have been referred to in a previous chapter. Surface temperature may not be affected at all or may be slightly elevated. There is sometimes marked crepitation on motion of the joints. This may be both felt and heard. Tenderness to pressure and pain on motion are not conspicuous symptoms, as a rule. In the knee joint there is oftentimes a slight tendency to permanent flexion. Palpation of the joint often gives the impression

of the presence of an excess of fluid, but careful study of the case enables one to detect synovial thickening and the villi may be easily rolled about beneath the examining fingers.

The above is the usual type of villous enlargement which occurs most commonly in the knees. A more unusual type is that in which there is less capsular enlargement and more relaxation of the joint membranes. Here also the crepitation is coarse and distinct and the motions of the joint are not interfered with to any appreciable extent. There is little if any tenderness over the articulation and no pain on motion. These cases are very frequently associated with a similar relaxed condition in other joints.

Cases illustrating infectious arthritis have already been presented. It is therefore unnecessary to cite further instances of villous changes, as they are in no way clinically distinguishable.

## CHAPTER IX

### GOUT

GOUT is a disease which has always been discussed in text-books of internal medicine or in monographs devoted to that disease alone. It is not with any intention of exhaustively treating the subject that it is taken up here. It seemed best however to give it such notice as might help to differentiate it from the other chronic non-tuberculous joint lesions which have been treated in this book.

The lesions of gout are rarely confined to any one locality and even when the joint symptoms are monarticular, tophi may generally be found in the ears or elsewhere. Though many of the cardinal symptoms of inflammation are recognizable about gouty lesions, there is little else to indicate that the disease is an infectious one. Everything points to a disturbance in metabolism as the fundamental cause for the gouty changes. The old theories of the relation of gout to uric acid have been proven erroneous as the chemistry of uric acid has been more thoroughly studied. (McCrudden.)

For the purposes of the present discussion it is chiefly necessary to consider the course of the disease and its clinical signs. It requires many years to develop the characteristic lesions of chronic gout. Localized collections of the bi-urate of soda attain large size in many cases (Figures 248 and 249) and are not likely to be confused with anything else, but in the absence of these characteristic accumulations there are conditions of the bones and joints which may closely simulate the lesions of other diseases. Acute pain and stiffness are pretty constantly associated with the development of gouty lesions, the former not always present, but manifesting itself in acute exacerbations at more or less frequent intervals. These paroxysms are frequently, though not constantly, associated with errors in diet or too heavy potations. Where the lesions are manifest chiefly in the fingers they simulate the infectious type of chronic

joint disease more than either of the other two types, but there is generally much less symmetry in the lesions and fewer joints are involved in gout. There is not as general a capsular thickening, and parts of the joint which are remote from the line of the articulation are more often concerned. This is true particularly of the chronic cases when seen between attacks, as in Figure 250. During the acute exacerbations there is much more general swelling of the tissues in the neighborhood of the joint, as is well shown in Figure 250.

Around the larger joints, as for example the knee, elbow, and wrist, the irregularity



FIG. 248.

FIGS. 248 and 249. Note the enlargements of the second phalangeal articulations and the bi-urate deposits in the metacarpo-phalangeal joints of the index and middle fingers. The same condition is seen in the foot, which is of the same patient.



FIG. 249.

and asymmetry of the lesions is more conspicuous. (Figures 251 and 252.) Restriction in motion and deformity at the affected articulation may be extreme and is largely due to osseous hyperplasia, as is shown in Figures 253 and 254.

The osseous changes in gout, as shown in the X-ray, consist

of three types. Destructive or absorptive changes occurring in the shafts of the bones, as for example the phalanges or the metacarpals, as is indicated in Figure 255. There are also multiple, small, more or less refractive bosses, as are shown in Figure 256. The hyperplastic lesions causing ankylosis are well shown in Figures 253 and 254. The soft-part lesions of the capsule and the deposi-



FIG. 250. Note the resemblance to infectious polyarthritis. (From Case II.)

tions of bi-urate of soda are clearly suggested by the X-ray, though the crystalline deposits are very radiable and are figured in Figure 257.

Observation of the foregoing changes as manifested in the X-ray and indicated on physical examination will generally enable one to make a diagnosis of gout. The urine in the stage just succeeding an acute paroxysm is saturated with uric acid, whereas during an attack and after it is over, the balance is restored.

The tophi in such superficial locations as the ear may be incised and a little of the bi-urate of soda removed for chemical test in doubtful cases.

In the treatment of gout mechanical appliances have very little



place. Diet and those drugs which seem to have a specific influence over the process, such as colchium, are the measures which give the greatest relief. The continued administration of hydrochloric acid is said to control the paroxysms. It is used for this purpose by administering sixty drops of the dilute acid in divided doses during the day. It should be still farther diluted before ingestion.



FIG. 251. The enlargements shown about the knees and over the great-toe joint are due to urate deposits. (Case I.)

The following two cases are reported as being fairly typical of chronic gout. All of the above illustrations, with the exception of Figures 248 and 249, were taken from these two cases.

**Case I.** Mr. F. C. D., 45 years. Complaint. — Pain in feet and all his large joints. Duration. — 14-15 years. Cause. — Worry (assigned by patient).

Family history. Mother died of dropsy at 67. Father died of old age at 73. He had occasional attacks of lumbago. Maternal and paternal aunts and uncles are well. Family has been a long-lived one.

History. In Deadwood and the Black Hills in '76 and '77,

where he lived a wild and rugged life. Twenty years ago he had typhoid fever, but at that time was very busy putting through a business deal and refused to accept his physician's advice and go to bed, so he kept about during the entire course of the fever. Has been a very active business man concerned in very large consolidating and organizing enterprises. Up to fourteen or fifteen years



FIG. 252. Note the enlargement of the right elbow and in the metacarpo-phalangeal and second row of phalangeal articulations. (Case I.)

ago he was always well and there has been no rheumatic history in his family or in himself. Fifteen years ago he had his first acute gout, which attacked his great toe joints, and from there it has extended to practically every joint in the body. He has been able during the past two years to temporarily control his acute attacks with a patent medicine which he carries and thus be quite active in his business.

Physical examination. Large man, well nourished, and muscular. Both feet held in rigid valgus, due to ankylosis of the tarsus. Small tophi are present beneath the skin in various parts of the foot. Large tophi are present in the region of the knees and elbows. These conditions are well shown in the photographs and X-rays.

Treatment. Diet and supports to the feet.

Case II. 1907. M. M. H., 48. Occupation. — Hotel keeper. American. Complaint. — Pain and stiffness in many joints. Duration. — Fifteen years.

Family history. Father died at 87 of old age. One brother and sister died of phthisis. Mother died of phthisis at 68. The disease was contracted late in life. Mother, maternal grandmother, and a great aunt on mother's side and an uncle of the patient had a chronic arthritis of the hypertrophic type in the second row of



FIG. 253. (Skiagram by A. W. George.) Note the obliteration of the line between the tarsal articulations, and the long spurs about the tibio-astragaloid joint. These prevented motion in these joints. (Case I.)

phalangeal articulations of the hands. There was no diabetes or gout in other members of the family.

Personal history. Patient was always well until he was 33 years of age, except for malaria and pneumonia twenty years ago. Fifteen years ago he was poisoned with arsenic while working in the silver mines of Colorado. This occurred two or three times and he was

obliged to leave. Four years ago he had purpura hæmorrhagica. He also had "mountain fever" while in Denver twenty-one years ago. Typhoid nine years ago. Has had no other diseases or infections. Always had a good appetite; has had no digestive troubles.

Present attack. The first joint trouble which he had was in the left great toe. At that time he was in excellent physical condition;



FIG. 254. (Skiagram by A.W. George.) Observe the proliferation of the olecranon and olecranon prohibiting motion to a considerable extent at the elbow joint. (Case I.)

had no injury; was working in a damp place, but was taking excellent care of himself; had no cause for mental anxiety. The joint attacked was the metatarsophalangeal. This was in the fall of 1886. In January, 1887, the left knee was attacked and about a year later the right knee. Recovery was not complete between these various seizures. From that time during the next five years he had repeated attacks in the left great toe and in both knees. During the first attack in his knees he had some fever. After that thinks he had none.

Ten years ago both hands and elbows became involved while he was in excellent general condition. He has on the average four



FIG. 255. Note the swelling of the first phalanx and the destruction of a part of the shaft of this bone. (Case I.)

or five attacks a year, usually in the late fall near Christmas time. They lay him up from one week to three or four months at a time, and seem to be associated with constipation. Has weighed on the



FIG. 256.

FIGS. 256 and 257. Observe the highly refractive nodules on the ends of the phalanges, tending to extend along the shafts of these bones.



FIG. 257.

average from 200 to 210 pounds for the past twenty years. During the last few years he has been able to control the acute attacks by the administration of a proprietary tablet which he carries with him always. His habits have been good.

Physical examination. Heavily built man, six feet in height, weighing 210 pounds; good color. Except for a few tophi in his ears there is little to be observed except in the joints. Over the lower legs there are some bronzed scars. Area of heart dullness is normal, as are also the sounds. Vessels are not atheromatous. There are no rales in his chest. Breathing is broncho-vesicular. Abdominal viscera show nothing abnormal on examination. The general character of the joint swellings is capsular, with some osseous thickening. There is a slight increase in temperature over the left forearm and hand, which at present are the seat of the most active disease. None of the other joints show increase in temperature. Both knees are flexed about ten degrees. Forcible extension causes pain. Left knee considerably swollen, particularly above the patella, though to some extent the swelling extends below this bone. Right knee one inch larger than the left over the patella; no difference above and below the patella. The right hip can be flexed  $45^{\circ}$ ; rotation is free. Left hip can be flexed easily to a right angle; no restriction in rotation or abduction. No atrophy of thighs. The interference with motion seems to be caused by bony obstructions or tophi. The functional use of the joints is considerably impaired. Shoulder motions not restricted in any direction. Right elbow cannot be extended completely. Supination restricted about a third. Right wrist is flexed; cannot be extended. Little finger at the second phalanx is much thickened by chalky deposits above and below the joint. Ring finger over the second phalangeal joint shows some lateral deposits. The middle finger shows a large deposit above the joint. Metatarsophalangeal articulations also show some deposits. No motion in the ankle joints. No general glandular enlargements. Left hand more acute than the right.

Diagnosis. — Gout.



## CHAPTER X

### HÆMOPHILIAC JOINTS

A BRIEF consideration of the manifestations of hæmophilia in the joints seems to be necessary in a consideration of the various forms of arthritis because of the importance of an accurate diagnosis. The external appearances and certain features in the history of hæmophiliac joints closely resemble tuberculosis and there have been a number of instances where fatal hæmorrhage has occurred because surgical operations had been performed upon cases of this sort under the supposition that they were tuberculous. The hæmophiliac diathesis is usually recognized by the observation of a tendency to more or less uncontrollable hæmorrhage from some one of the many trivial cuts or abrasions to which one is liable. A knowledge of this condition is therefore generally acquired in early life. In some cases however, and these are the ones where great difficulty may arise in diagnosis, the earliest evidence of the tendency to hæmorrhage manifests itself in some joint. Furthermore, hæmorrhage from skin cuts or abrasions may not often occur in certain patients, whereas hæmorrhage from mucous and serous membranes may be quite common and difficult of control. Not much is known concerning this condition etiologically or pathologically. It is an hereditary condition in many cases and seems always to be manifested in these cases in males and maternally transmitted. Whitman calls attention to one family which has been followed through four generations and 33% of their male descendants were bleeders, 18 of whom died of hæmorrhage in infancy. Whether the underlying cause of this condition will be found to be some defect in the coagulability of the blood or a defective construction of the walls of vessels is uncertain, but perhaps the weight of evidence so far is in favor of the latter theory. Injury seems to be the exciting cause of most of the joint hæmorrhages and it is not necessary that the injury should be of

great severity. Twists or wrenches as well as direct violence may be competent to cause rupture of the weakened vessels. The joints most frequently concerned are the knee, the elbow, and the hip. Sometimes more than one articulation may be involved.

After a slight trauma to a joint a slowly accumulating effusion appears which may cause a good deal or very little pain or discomfort according to the rapidity of its accumulation. There may be tenderness and heat over the swollen joint, but fluctuation is not quite as evident as in purely serous effusion and capsular thickening is not as prominent at least in the fresh cases as it would be were the cause for the arthritic symptoms an inflammatory process causing infiltration of the synovial capsule. There may be considerable elevation of the bodily temperature, as there often is after the severe trauma which results in a simple fracture, in both cases the temperature being due to the absorption of clot. Motion in the joint in the early cases is not restricted unless it be by the abundance of the effusion or the pain of motion. In the late or old cases, particularly if more than one bloody effusion has occurred, there may be more or less fixation of the joint and atrophy of the muscles about it. In these cases there has been an organization of the effusion and adhesions have formed which more or less completely obliterate the upper portion of joint pouch and consequently interfere with mobility at the joint. One effect also of the presence of the effusion is sometimes to cause a proliferation of cartilage and bone which may closely resemble the osseous spurs seen in the hypertrophic form of non-tuberculous joint disease. (Figure 258.)

There is discoloration of the skin about many of the joints in which bloody effusions have taken place, but these are not seen early in the occurrence of the hæmorrhage. The chief reliance in diagnosis must be placed upon the history of the patient and his family history. Treatment consists almost entirely in protection of the joint by splints or spicas, and where the condition is recognized while the effusion is taking place attempts may be made by the administration of adrenalin or other drugs which will favor the coagulability of the blood to check its flow. Not much can be

done to favor the absorption of the clot. There is clinical evidence to suggest the possibility of an infectious factor in certain of the hæmophilic joints. We have had one case with throat



FIG. 258. Note the rarefaction of the femur and tibia and the lipping of the patella. This is the result of the disuse and is not a change pathognomonic of hæmophilia. (Case II.)

symptoms whose arthritic lesions were much relieved by local treatment of the throat.

The following two cases are reported as typical of the more common joint hæmorrhages.

**Case I.** S. H. Age, 10 years. December 29, 1903.

Diagnosis.—Hæmophilia (hip).

The patient has had several hæmorrhages following minor opera-

tions, on one or two occasions narrowly escaping death. There are no other bleeders in the family, but his behavior evidently puts him in this class. Two days before being seen he fell, straining the left hip.

He had very little pain at that time. This has gradually however increased, and at the end of twenty-four hours all the joint motions were limited and there was a temperature of 102. At this time the left hip was flexed at 35° and abducted at 20°, and all motions were quite painful. No other joints were affected. No shortening.

A plaster spica was applied and kept on for about a month. This was omitted early in February, 1904, and a gauze spica substituted. Motions gradually returned, but there is considerable limp.

In September, 1904, there were evidently many adhesions in the hip joint, as was evidenced by the stiffness. Very few other symptoms.

April, 1905.—Patient was doing well, except that he still limps. He has sustained a slight injury by being run into by another boy, after which there was some evidence of hæmatoma in the left knee.

December, 1905.—Patient has been gradually improving. Has very little limp, and his only subjective symptom is stiffness when he first gets up from a sitting position.

June, 1906.—Very little trouble with the hip until three days ago, when the leg became painful, the principal disturbance seeming to be in the knee joint. There was however no evidence of any trouble in that situation.

November 7, 1906.—Patient was in good condition. No pain in the joint and only about 15° of motion in flexion. 20° of free abduction at present and about half the normal amount of inward rotation.

**Case II.** Mr. E. H. M. Age, 22 years. April 8, 1902.

Diagnosis.—Hæmophilia (knee). Vide Figure 258.

Patient has been a bleeder since a child. When he was four years old had his first joint trouble referred to his ankles, thought to be rheumatism. Attacks of trouble at infrequent intervals,

lasting for a few weeks or months. Four years ago his knee commenced to trouble him. Shortly after the onset of the trouble in the knee the motion began to be restricted, and there is now only about  $20^{\circ}$  of motion. The attacks have all come on after a slight wrench and the swelling slowly increases for a time afterwards. There has been some suggestion of intermittency of a periodic character in the swelling at the ankles.

September 20, 1902.—Has worn a leather leg splint to protect the knee joint for six months. There have been no acute attacks, and there are  $40^{\circ}$  of motion at the knee at the present time. In the left great toe and the ankle on that side there has been some swelling following a slight wrench. During the latter part of August of this year he wrenched the wrist and since then has had more or less trouble there and in the elbow. Not a great deal of swelling, but some limitation in motion. While shooting a few days ago the concussion of the gun produced a hæmatoma in the upper arm, which has extended down so that the entire arm is painful.

December, 1903.—Has had very little trouble during the past year. Only slight effusion has accumulated in the knee on one or two occasions when he had wrenched the joint. There is now about  $30^{\circ}$  of motion in flexion from a position of complete extension.

September, 1905.—Sustained an injury over the second phalangeal joint of the right hand, which has been bleeding subcutaneously for four days. This became somewhat septic. Some fluid in the joint. Has quieted down, however, under corrosive dressings.

November, 1907.—During the past year and a half the patient has been quite well. Has been living an out-of-door life in California during the winter, and in New Hampshire during the summer. Apparently had some heart difficulty, but examination gave no evidence of any lesion.

January, 1908.—Has had a recent attack of trouble in the throat, but no definite diagnosis has as yet been made.

This has been a typical case of hæmophilic lesions in the joints, the limitations in this case, as in the previous one, being due to the organization of a clot in the joint.

## CHAPTER XI

### INTERMITTENT HYDROPS

AMONG the many types of joint disease which visit an orthopædic clinic there are quite a number that are characterized by a periodicity which is the striking feature in their symptomatology. These cases occur with about equal frequency among men and women and are noted in adult life. Not much is known concerning the etiology of the condition, though it is supposed that vaso-motor changes are responsible for the joint symptoms. Various conditions have been noted in association with this intermittent type of joint swelling, but whether they stand in the relation of cause or effect or whether they are purely coincidental is a matter which has not as yet been determined. Foreign bodies within the affected joint have been associated with one such case known to the writers, while psoriasis and infectious arthritis of the gonorrhœal type has been present in two other instances. In most cases however the condition seems to be idiopathic.

The cases are more often multiple than monarticular and are generally symmetrical. They are almost always confined to the joints of the lower extremities, as for example the knees and ankles, generally the former. In one of the cases which we have described both knees were affected maintaining a regular periodicity in their attacks for many years. Both ankles however showed similar tendency though much less pronounced. The most striking clinical feature is the intermittency of the swelling of the joints. Pain is not very constant or severe. When the swelling has attained its maximum the distention of the capsule is sufficient to cause some pain but not the acute discomfort of an inflammatory process. In the interval between attacks the swelling entirely disappears and

the joints appear perfectly normal and function in a perfectly natural manner. The periodicity is an absolutely definite one for the particular joint or joints. The swelling begins at a certain time, attains its maximum within a given period, and occupies a constant interval in its recession. In the joints which are symmetrically involved the swelling alternates as a rule so that when one is at its maximum its fellow is wholly free from enlargement. The cycle may occupy from three to four to nine or ten or more days, but is so regular that the patient is able to say in advance whether he will be able to undertake exercise which involves the use of the affected joints at a given time or not. The cycle may occasionally be disturbed but almost invariably resumes its accustomed course after a short intermission. Sometimes the swelling may entirely cease for periods as long as six months or even more, only to recur without any apparent reason. There is a tendency to spontaneous recovery in most cases after varying intervals, such intervals often extending over a considerable number of years. The swelling is characterized by a capsular enlargement and is not due to any considerable accumulation of fluid within the joint. There may be a slight increase in the surface temperature and moderate tenderness to deep pressure over the capsule. Motion at the joint is not restricted except at the height of the swelling when there may be some mechanical obstruction. Active and passive movements of the joints are not painful and there is seldom any crepitation. Atrophy of the muscles is not common and would be difficult of determination because of the symmetrical character of the joint lesions. The variation in size of the affected joints may amount to as much as two inches.

In the treatment of this condition we are far from having a rational basis upon which to work. Nothing is known of the pathology and there seem to be no constant etiologic factors in the cases. The theory that vaso-motor disturbances are responsible is purely inferential and is based upon the cyclic character of the symptoms and the fact that some cases have seemed to be cured by the administration of drugs whose therapeutic action is antispasmodic.

There does not seem to be sufficient evidence however of constancy in the relief of symptoms where antispasmodics are used to give very much support to this theory and it therefore has to stand largely upon the one fact of the intermittency in symptoms which seems to characterize certain other conditions which are vaso-motor in origin. Granting that vaso-motor changes are responsible it is still necessary to explain how these are brought about. Fixation with protection of the affected joints does not seem to be competent to prevent the periodic swellings, neither are they necessary for the relief of the symptoms of pain and discomfort from which these patients may suffer. The prolonged administration of Quinine and Arsenic have been attended with good results in certain cases. Operative interference in two of our cases, which are here reported, seems to have effected a cure in one instance but to have had only a temporarily beneficial effect in the other. On the supposition that some obscure infection might have been the cause, the opsonic index was taken in two cases, one of which was also previously operated upon. The index seemed to indicate in one case that a streptococcus was the infective agent, in the other it was the staphylococcus. In neither case was any benefit derived from inoculation with the appropriate vaccine. The following cases are reported as representing two rather different types of the same affection.

**Case I.** (Intermittent Hydrops.) A. R. Age, 34 years. June, 1906. Complaint.—Pain, swelling in both knees, both ankles. Duration.—Seven years. Cause.—Unknown.

Patient comes from a neurotic family and himself has been very nervous. He has been a hard student and has lived a rather sedentary life. For seven years he has had slight pains in the knee joints. Gradually these pains have increased, and associated with them have been fever and localized tenderness. At the beginning of the trouble the swelling and pain would come on at intervals of eight or ten days, then there would be a remission of several months, when the eight or ten day periodicity again recurred. The last attack was one year ago. Associated with that attack there was a



gastric crisis during which his digestion was very much upset and he had many stomach symptoms of a distressing character and was troubled with insomnia. Has had psoriasis during practically all of this time. When the psoriasis has been worst the joint troubles have been least aggravated and when the psoriasis has disappeared the joint troubles have simultaneously recurred. The right knee has always been worse than the left until the present attack, when the reverse has been true. General condition is fairly good.

Physical examination. — Both knees quite fully distended, the swelling being confined to the synovial sac and the quadriceps pouch. Motions in the joints are free. In the anterior part of both ankle joints there is some swelling, apparently in the tendon sheaths. It is not painful and appears to be a tendo-synovial condition.

Thinking that there might be some source of infection through the upper air passages, it was suggested that a throat examination be made, but no extensive disease of the tonsils or nasa-pharynx was found. There were some cheesy crypts in both tonsils. There was no evidence of syphilis.

A letter from the physician who had him in charge when his gastric crises were most pronounced reports that they were practically cured by psychotherapy.

Because of the persistence of the intermittent distention of the knee joints an operation was advised. The right knee joint was opened on September 15, 1906, and a large amount of clear fluid escaped. A culture from this was negative. There were a large number of fattily degenerated fringes in the joint, and in the upper part of the quadriceps pouch there was a good deal of fibrin. All of this was thoroughly cleaned out. Convalescence was uneventful. After this operation the patient had a severe nervous upset characterized by melancholia, and associated with this was much hiccoughing and vomiting. A month after operation the nervous symptoms had practically disappeared. There was no swelling in the joint and normal motions could be obtained. Patient was able to walk with a cane.

In November, 1906, because of a slight tendency to increase in the swelling in the non-operated knee, injections were commenced, following the opsonic index as a guide, with a vaccine made from staphylococcus aureus. The fingers of both hands seemed to participate in the swelling of the knees. From this time on he was given inoculations with the staphylococcus until the early part of January, 1907, when he had another attack of stomach disturbance and a nervous upset. He vomited very profusely and had a series of attacks of hiccoughs which lasted for several days. The swellings of his knees, ankles, and fingers entirely disappeared during this nervous attack, as did also his psoriasis, and his skin to all appearances was as clear as it ever had been. After this attack passed off the swelling again appeared in the non-operated knee to about the customary amount and recurred with the usual frequency; very slight swelling in the operated knee. The psoriasis also returned as the nervous condition improved.

The latter part of January, 1907, the opsonic index pointed to another organism as being a possible cause of the trouble, namely, Schüller's bacillus, which is supposed to be the specific organism of villous arthritis. Accordingly inoculations were carried on with this through February and a part of March, without however any material change in the condition of the joints. The intermittency of the swellings was the characteristic feature of the trouble and the periodicity was the same, though perhaps the extent of the enlargement of the joint had been somewhat diminished. The operated knee was in almost every attack less swollen than the non-operated one.

A report from the patient through a relative, dated the latter part of the summer of 1907, indicates that he is in general in excellent health, and that for several months there had been no exacerbation of trouble in the joints. There had however been at other times periods of an equal duration during which there had been no joint symptoms.

**Case II.** Miss E. O. S. Age, 26 years. September, 1906. Complaint. — Swelling of knees. Duration. — Six years.

Family history was entirely negative, except that the mother had tuberculosis of the lungs, of which she had been cured.

Patient had always been perfectly healthy. She has worked hard in an office down town, keeping books. About six years ago without any known cause her knees commenced to swell alternately, the swelling reaching its maximum in each knee at intervals of seven days, four days being required for attaining the maximum, and three days for recession. There was very little pain, some discomfort, due to the excessive enlargements, and a slight amount of limp when the joints were most swollen.

Physical examination. Right knee much swollen, the swelling being represented largely by fluid; very little capsular infiltration. The left knee is at its smallest, because the two alternate in size. Motions of the joint not restricted at all. Color good. No other joint enlargements; general physical condition seems excellent.

Knees were bandaged and she was given two grains of quinine four times a day, which she continued for a month. During this period the right knee entirely skipped one period of swelling. The left one has swollen rather less since giving the quinine. The opsonic index was taken in the latter part of November, 1906, and her blood was then found to be "low" to the streptococcus. Accordingly she was given streptococcic vaccine at regular intervals from that time until the early part of April, 1907, without any consistent improvement. During the time that she was having the vaccines injected she omitted the quinine. In April, 1907, vaccines were omitted and the patient was put upon Aiken's Tonic tablets and quinine. This treatment she kept up until the 1st of June, and during that time the swelling was rather less, though the periodicity had not been disturbed.

The patient was asked to keep a record of the measurements above the knee, over the patella, and below the patella on both legs, which she did from June 2d to September 29th, as the following measurements show:—

## INTERMITTENT HYDROPS

1907	Above.	Right. Over.	Below.	Above.	Left. Over.	Below
June 2.	13	13½	12½	13	14	13
June 9.	14½	14	13½	13	13½	13
June 16.	13½	13½	12½	14	13½	13
June 23.	13½	13½	13½	13	13½	13
June 30.	13	13½	12½	13½	13½	13
July 7.	13½	13½	13½	12½	12½	13
July 13.	13	13½	13	13½	13½	13
July 20.	13½	13	13½	12½	12½	13
July 27.	No swelling.					
Aug. 4.						
Aug. 10.	13½	13½	13	14	14	13½
Aug. 20.	13	14	13½	12½	13½	13
Aug. 25.	13	13½	13	14	13½	13
Sept. 1.						
Sept. 8.	13½	13½	12½	14	14	13½
Sept. 15.	14	14	13½	13½	13½	12½
Sept. 22.	13½	13½	12½	14	14	13½
Sept. 29.	14½	14	13½	13½	13½	13

On October 5, 1907, patient reports that during the summer the knees have kept their regular periods of swelling and have attained about their average size at the height of the swelling. She was then advised to omit the Aiken's Tonic and was put upon four grains of Sulphate of Quinine given in a single dose at the commencement of the period of swelling of each knee. This dose was to be continued during the succeeding four days; in conjunction with this Fowler's Solution was administered and continued for a period of three weeks, after which it was omitted for two weeks and then resumed. During the winter of 1907-08 there has been no change in the condition, except that the degree of swelling is apparently rather less when she is taking quinine than when she was being inoculated with vaccines or was not taking anything.

## CHAPTER XII

### THE TREATMENT OF FAULTY WEIGHT-BEARING IN "WEAK" AND "FLAT" FEET

It is with great hesitation that one ventures to discuss the treatment of static foot conditions. So much has already been written on the subject by masters of the art that triteness can with difficulty be avoided. And yet the opportunity to watch the treatment of these conditions in large clinics, both private and public, has led to the belief that routine is largely the order of the day. One justly famous orthopædic surgeon, with a very large clinic, never applies a foot-brace of any kind to a purely static error, and manages to accomplish his ends, and to satisfy the majority of his patients. Another equally famous man practically never treats a case of faulty weight-bearing without the application of a flat-foot plate.

The routine varies, to be sure, and different routines have different values, but the evils of routine exist in both.

The common conception of the laity, that a weak, painful foot means a fallen arch, and that an artificial arch must be obtained and continuously worn afterwards, like a set of false teeth, is due largely to this very routine for which the orthopædic surgeon is responsible.

That this conception is wrong needs hardly to be emphasized theoretically, but practically the need of reform in our treatment of weak feet and faulty weight-bearing is, to our minds, a crying one.

The conclusions drawn from observation of these cases may be briefly stated as follows:—

1. A rigid arch supporter worn for several months, while relieving symptoms in the majority of cases, weakens the foot and tends to make the wearer dependent upon it.
2. The prolonged use of such rigid supports is, in the great majority of cases, unnecessary, if proper treatment is administered at the appropriate time.

3. The aim of the surgeon should be to strengthen the weak structure, and not simply to temporarily relieve symptoms.

4. In the cases of simple weak foot the calcaneo-astragaloid articulation demands most attention.

5. In the severe cases of long standing, operative measures may be more commonly employed and offer lasting relief.

To define terms is perhaps unnecessary, but the confusion in their use in some of the literature makes it seem wise.

"Valgus" and "Varus" are of course too well understood to need more than the adjectives rigid, or flexible, as prefixes, to make them descriptive. The word "Pronation" is used to describe a condition of faulty weight-bearing which consists of an apparent sagging of the internal malleolus and an eversion of the foot, which brings the line of weight-bearing too far to the inner side. The arch may be affected to the extent that eversion lengthens the inner border and so diminishes the height of the arch.

"Reserve Pronation" is a useful term first used by Drs. Lovett and Cotton to describe the ability of some persons with pronated feet to pronate still more by relaxing certain muscles, showing that there was still considerable power in the muscles to partially overcome the pronating tendency. "Supination" may be defined as the opposite of "Pronation."

Certain essential anatomical points may well be discussed early, since their significance is important in relation to treatment. As has been shown by Drs. Lovett and Cotton in a series of interesting experiments, the joint at which most of the pronation takes place is the calcaneo-astragaloid.<sup>1</sup> The calcaneal facet is roughly dome-shaped and slopes downwards from behind forwards. On this the astragalus may partially rotate and slide downwards.

The astragalus, held as it is in the mortice of the malleoli, must carry the leg with it, or else the whole foot must be conceived as rotating on the astragalus into a position of valgus. To determine for one's self the fact that at this joint most of the pronation occurs, the following experiments may easily be tried. In the flexible foot

<sup>1</sup> *Transactions, American Orthopædic Association, 1898.*

of a cadaver the amount of possible pronation is measured. A wire nail is now driven transversely through the malleoli and astragalus, thus immobilizing the ankle joint proper, so far as lateral or rotary movement of the astragalus on the tibia is concerned. The pronation now measured is found to be approximately the same as before.

A second wire nail is driven through the scaphoid into the astragalus, thus locking the medio-tarsal joint. The possibility of pronation is still very marked. So one may go on immobilizing the other articulations with the same result until a long nail is driven from below upwards through the os calcis into the astragalus, when the possibility of pronating the foot will be found to have almost entirely disappeared. If one removes the other nails, the same inability to pronate remains, as long as the os calcis and the astragalus cannot move on each other.

By a study of many ligamentous wet specimens in the Anatomical Laboratory of the Harvard Medical School, the strength of one ligament, the calcaneo-scapoid, was ascertained. Like many other facts mentioned in various descriptive anatomies, the importance of this structure was not realized until studied in the dissected specimen. This broad tough band forms the floor of the astragaloscaphoid joint, and carries the scaphoid and the longitudinal arch downward, as the rotation and descent of the astragalus on the calcaneal facet occurs in pronation.

As Lovett and Cotton have shown, the relations of the articular surfaces permit an outward movement of the scaphoid when the head of the astragalus rotates inwards, and the fore part of the foot follows the scaphoid "*en masse*."

If the scaphoid and os calcis are fixed in their relation by the contraction, for instance, of the tibialis posticus, no rotation of the astragalus can take place. There are no muscular insertions on the astragalus, which is the sole transmitter of the body weight.

A brief review of the muscular actions is appropriate in relation to the discussion of exercise treatment of weak feet. The tibialis posticus, whose tendon lies in a groove beneath the internal malleolus, most perfectly overcomes pronation by pulling inward on

the tubercle of the scaphoid, fixing it in relation to the os calcis, and preventing rotation of the astragalus. It is a weak plantar-flexor of the foot, but when its contraction is simultaneous with that of the tibialis anticus inserted into the internal cuneiform and a strong dorsal flexor, adduction and dorsal flexion is the result, and pronation becomes supination. The flexor longus hallucis is also a strong adductor with very powerful leverage. The flexor accessorius or flexor brevis digitorum is the only muscle which by its bowstring-like span from os calcis to toes affects the arch directly.

The peroneus longus and brevis swinging round the external malleolus, the former running across the sole of the foot to the base of the first metatarsal or internal cuneiform, and the latter inserted into the base of the fifth metatarsal, together with the peroneus tertius are strong abductors of the foot and favor pronation and the valgus position.

The other leg and foot muscles seem to influence pathological pronation or supination to a comparatively slight degree.

Feet demanding treatment for static error at once divide themselves into two great classes, Flexible and Rigid.

The former are far more easy to correct and never need operative measures. The rigid ones, on the other hand, nearly always demand either bloody or bloodless surgery, and must in some way be rendered at least fairly flexible before the symptoms can be completely relieved.

#### FLEXIBLE FEET

The flexible weak foot, in the vast majority of cases, represents simply an overstrain. One is generally rewarded by discovering the underlying cause for this, if a patient search is made. If, on the contrary, after the manner of early medicine, we attempt simply the relief of symptoms, our ignorant patients will often thank us for a freedom from pain which is in reality a bondage of steel.

The general physical tone of the patient should be our first consideration. A relaxed, debilitated condition makes itself evident



at the point of least resistance and the strain of weight-bearing, owing to our universally constricting and imperfect shoeing, is most keenly felt in the feet.

No matter how perfectly our appliances fit, no cure can be effected until the proper muscular and ligamentous tonicity is established. The cause may be found to lie in an occupation which puts constant strain on the ligaments, in a rapid or gradual increase in weight, or in a change from an inactive to an active life. Unless this etiologic factor be discovered, treatment will be as imperfect as our investigation has been superficial.

Expediency may at times demand the sacrifice of an ideal, and long-standing conditions offer only the opportunity for relief and not cure, but we feel very strongly that these justifications of palliative treatment should be more seldom accepted, and that they often represent excuses and not scientific reasons.

#### SIMPLE WEAK RELAXED FEET

The terms, "flat-foot" and "broken arch," have caught the public fancy, and the attention of the laity has been directed to the feet. This has undoubtedly diminished the ingestion of sodium salicylate, and has helped humanity in another way by stimulating people to consider their symptoms most carefully in the early stage of faulty weight-bearing.

Hoffman has conclusively shown that there can be no absolute standard of the height of the arches. This varies in different individuals within wide normal limits. It is to be remembered that a normally high arch beginning to suffer strain is vastly more painful than an arch absolutely much lower, but normal for the individual, and that the early pain is often more severe than after the ligaments have been stretched and the foot "settled" somewhat.

In these early cases where the longitudinal arch without weight-bearing is normal for the individual, and where the pronation is slight, we feel there should be no application of a rigid plate. A search for the underlying cause should be made, and temporary rest of the strained structures secured, either ideally by freedom

from all weight-bearing, or by repeated stirrup strapping in a slightly adducted position with adhesive plaster strips, the application of a carefully fitted spring plate, or a Thomas heel, or a combination of both. By a spring plate we mean an accurately shaped brace made from a cast taken without weight-bearing, of 21-26 steel or of celluloid, and slightly higher than the arch. This allows the foot some action in walking, and gently applies restoring pressure when at rest.

A Thomas heel by propping up the os calcis, and preventing the rotation of the astragalus, while the front of the foot is inverted in weight-bearing, will often relieve the strain and accomplish the purpose.

After the tired structures have been rested for a few weeks, and the underlying cause combated, massage of the feet and lower leg muscles should be given, and in a few days exercises begun. If resistance is used in these exercises the end is accomplished more quickly. The patient should be encouraged to gradually give up the spring appliance, if one has been used. The Thomas heel should be worn for several months, the elevation on the inner side being gradually diminished. It is perhaps needless to emphasize the necessity of obtaining at the outset shoes which do not contract the feet, and are sufficiently flexible to allow corrective muscular action.<sup>1</sup>

#### PRONATED FEET

With this class much the same course of treatment is advised. Here pronation seems the essential feature, and "reserve" pronation is very slight or entirely absent. Occasionally in this class a rigid plate, constructed with high lateral flanges, should be furnished for the first few weeks of treatment. The Thomas heel, carried perhaps a half-inch forward on the inner side, and raised one-quarter of an inch more at the forward inner corner than on the outer side, should be worn for a period, the length of which should be determined by the response of the muscles to exercises, and the return

<sup>1</sup> *Journal, American Orthopaedic Association*, July, 1905.

of reserve pronation. Exercises are here the most important element in securing permanent relief.

Another class includes those cases, fortunately more rarely seen, of pronation plus valgus. Here the longitudinal arch, with and without weight-bearing, is depressed and tender to plantar pressure. There is no reserve pronation and the abduction is most marked. These feet are more difficult to permanently relieve, without permanent apparatus of some kind, than others of the flexible type. We believe that tendon transplantation is worthy of serious consideration in some of these cases, though we have lacked opportunity to attempt it. A rigid support is practically always required at the start, planned not only to overcome pronation, but to prop up the relaxed and stretched arch. The plate at first should be made only slightly higher than the weight-bearing arch and then, at two or three week intervals, gradually raised, until an approximately normal height for the individual has been attained. The wearing of the rigid plate should now be limited to the hours when most strain of weight-bearing is borne by the feet, and a high spring plate substituted.

Under exceptionally faithful and long-continued massage and resistive exercises, we have seen such feet improve in contour, regain much of their normal arch height, and be able eventually to stand much hard use without the help of plates.

Such devotion to treatment is seldom found however when it entails so much expenditure of time and energy, and relief can be had by the constant use of supportive apparatus.

#### METATARSALGIA

The history of a typical case of metatarsalgia, or Morton's toe, is so characteristic that little doubt can be had as to the diagnosis. A scientifically accurate description as to the causative factor is still lacking. That it is associated with a relaxed anterior arch, and especially an abnormally moveable metatarsal head, usually the fourth, seems unquestioned. The response to treatment is to the physician at times a matter of doubt, though, when successful,

often seems to the patient little short of miraculous. This condition is practically confined to the flexible type of feet and is relieved if we restore the transverse arch, and succeed in sufficiently immobilizing the head of the offending bone or bones.

If this condition is met in a case of weak foot demanding plate treatment for the longitudinal arch, an extension of the support under the anterior arch will usually relieve. If the symptoms are referred only to the front of the foot, the correction of the probable slight pronation, together with a light support of anterior arch, is our best procedure, since we can thus better hold the latter. A light spring pad is often sufficient.

Occasionally, no support which exerts pressure from beneath alone, gives complete relief, and restoration of the arch, by lateral compression of light spring steels attached to the plate, or by elastic or unyielding bandaging, must be employed.

We should look to exercise, active or passive, as our rational cure, though long persistence in them is usually necessary and does not offer lasting relief in all cases.

Obstinate forms will be encountered which fail to yield to supportive and gymnastic measures, and we must fall back on excision of the metatarsal head as an almost sure relief from the distressing intermittent pain. Resection of the nerve is in our opinion usually unnecessary.

## RIGID FEET

### GENERAL CONSIDERATION

The difficulties in the satisfactory treatment of rigid feet as a class, while by no means insurmountable, will be recognized by all as considerable.

Weight-bearing determines that the deformity, in practically all cases, shall be valgus, and the problem presented is to obtain a completely or partially flexible foot, capable of maintaining, without or with artificial support, correct weight-bearing lines.

The social status of the patient determines in some measure the extent to which treatment can be carried, since on the leisure

and persistence of the individual depend largely the success of treatment.

It is also at once obvious that the amount of use to which the feet are to be subjected must influence the extent of correction. Thus, when a constant future strain in walking or standing is inevitable, we must be more determined than when a more or less sedentary life is to be led, and freedom from acute discomfort is the only boon sought.

(a) Muscular spasm or actual muscular contracture.

We must determine first whether the rigidity of a foot is due to simple muscular spasm, to actual muscular contracture, or to adhesions, fibrous or bony. Often an examination without an anæsthetic may determine this fact, but our own experience has taught us that it is best in most cases to advise an examination under an anæsthetic, having obtained the consent of the patient to any corrective measures which at the time may seem wise.

Simple muscular spasm will disappear under full anæsthesia. Contractures will be little influenced, and adhesions not at all. The commonest form which we have seen has been spasm of the peroneals, and, although the foot be markedly over-corrected and retained for a long time in plaster, the tendency to recurrence is marked.

Excision of about three-fourths of an inch of the tendons and sheath of the peroneus longus and brevis has in Mr. Robert Jones' hands been efficient in relieving the condition. The authors place most reliance on manipulation and retention in the over-corrected position and the use of specially devised plates. The frequent association of this condition with lesions of the sacro-iliac joints is suggestive.

Where, in the rigid valgus cases, tendons are found to be actually contracted, they should be divided. In the rare types of contracted feet, where the Tendo Achillis is usually short, a tenotomy, or better, a lengthening of the tendon, should be undertaken.

We have lately followed a number of cases of extreme muscular

spasm treated by corrective adhesive strapping and daily exercise in a universal foot-exercising machine.

The limbering out began after the first treatment; was complete after three or four, and after a month the feet have remained flexible and symptomless.

Whether this machine will supersede the operative procedures the future alone can tell. That it deserves fair trial is undoubted.

(b) In those cases in which the rigidity is due to fibrous adhesion, from the strain of static error, the inflammatory processes of infectious arthritis or the results of trauma, forcible manipulation under an anæsthetic is almost indispensable. If one is the fortunate possessor of strong hands, this may be done manually, but the Thomas wrench, if one is dexterous in its use, is usually more thorough and efficient. Long-continued, uninterrupted fixation after this over-correction we feel is unwise and unsatisfactory in result.

Within twenty-four or forty-eight hours the cast should be split, and the feet at first gently and later more vigorously moved, being returned to the retentive over-correcting cast. Within a week active exercises should be begun, and these procedures, uncomfortable as they often are, including, if necessary, anæsthesia, should be persistently repeated until the desired flexibility is obtained and can be retained under use. A supportive and corrective plate is usually a necessary addition to the treatment.

(c) When the rigidity is due to bony ankylosis or overgrowth, we are confronted with a much more serious condition. Very forcible manipulation and "wrenching" under an anæsthetic may result in bettering the position, but will hardly restore flexibility.

If the obstruction to motion is caused by bony spurs which have their etiology in some traumatic or inflammatory lesion, their removal by open incision offers a chance of return to more normal motion. If the spurs are the result of a chronic rheumatic process of the hypertrophic type, we have no warrant that their removal will not be followed by recurrence, and palliative measures are surely wiser in most cases.

If tarsal fractures are demonstrated by the Röntgen ray correct-

ive osteotomy, in suitable cases, is the rational procedure. Not a few cases have been met in which, from long weight-bearing strain, the head of the astragalus and sometimes the scaphoid, have partially subluxated. This bulging on the inner side has represented a bony obstacle to correction, and a trying deformity. In three of these cases, now followed for three or four years, removal of the scaphoid has been performed, and by forcible manipulation the inner border of the foot shortened. One of these cases was in a waitress who now is free from symptoms, with a partially flexible foot and a correct weight-bearing line. The other two are able to do house-work without discomfort, and none of the three wears plates. In long-standing congenital deformities of the tarsal bones osteotomies and divisions of the metatarsal ligaments are usually necessary.

Much has been written on the operative treatment of hallux valgus and hallux rigidus. We believe that the Huter operation of removal of the metatarsal head is almost uniformly satisfactory, when a proper operative technique and after-treatment have been observed.

#### CONCLUSIONS

The exercise treatment of weak feet is admitted by all to be rational and desirable. That it is much neglected in private work, and practically unemployed in most hospital clinics, we feel sure. The blame for this cannot be wholly laid at the physician's door, for, in the busy lives of to-day, a fifteen minute earlier rise in the morning or a delay of the same time on retiring represent a serious inconvenience. In private work, by regular office appointments, we can have this exercise treatment supervised and should make the patient feel that it is as important as exercise work in scoliosis. The exercises advised by Ellis<sup>1</sup> are admirable, and can be supplemented by others of the same nature but offering variety.

The relation of the comparative strength of the adductors and abductors of the foot is significant in the study of static foot conditions. We believe that a lack of muscle balance is of great import-

<sup>1</sup> *Lancet*, September 25, 1886.

ance in the development of foot strain and that the establishment of a proper balance is a great factor in the cure of weak feet.

Each group may be studied as a whole, not attempting to determine accurately the exact force of each component muscle of the group. Such valuable studies have been made on the tibialis anticus<sup>1</sup> and flexor longus hallucis.<sup>2</sup>

The method used in testing is as follows:—

With the patient seated, the knee is flexed at about forty-five degrees, the heel resting in a shallow cup-shaped depression in a base-board, A (Figure 259), and the foot held at a right angle with the leg. The thigh is fixed to prevent its rotation and lateral motion (e. g., by adjustable pieces, C and D, Figure 259), either of which would have vitiated the results. A padded leather strap, A (Figure 260), on which is strung a stout catch-hook, is fastened about the foot just behind the great-toe joint and buckled tight.

The foot is then abducted and a Chatillon spring balance, B (Figure 260), registering up to fifty or sixty pounds, is attached, one end to the catch-hook on the strap and the other to a fixed point to the outer side of the foot, e. g., B (Figure 259). The patient is now directed to slowly adduct the foot with the greatest possible force, and the number of pounds pull as indicated on the balance scale recorded. The pull of the abductors is then measured in a similar manner.

Measurements of one hundred and twenty-three feet form the basis of the following averages. About forty of these were taken by Dr. A. T. Legg independently at the Hospital.

For purposes of statistical convenience they have been divided into four groups.

#### I. Normal feet.

By this is meant feet which in standing and walking were practically free from pronation and in which there was no evidence of objective or subjective foot weakness.

<sup>1</sup> R. Giani, *Zeitschr. f. Orth. Chir.*, vol. 14, p. 34.

<sup>2</sup> C. Hübscher, *Zeitschr. f. Orth. Chir.*, vol. 17, p. 482.



## II. Symptomless pronated feet.

That is, feet which while giving rise to no symptoms or only those of vague tire, yet showed faulty weight-bearing lines and seemed to have the potential of trouble.



FIG. 259. Testing and exercising apparatus combined. Stool and pieces for fixing the thigh adjustable.

III. Weak or strained feet, which were flexible but markedly pronated and gave rise to definite symptoms of tire and foot discomfort.

## IV. Acute "flat-foot."

These feet were fairly flexible, but showed signs of acute strain, and were swollen, congested, tender, and very painful.

I. The number of normal feet tested was twenty-two. The

ratio of the average strength of the adductors to the abductors was:—

Adductors, 10.

Abductors, 8.2.

II. The number of symptomless pronated feet tested was twenty-three. The ratio of the average strength of the adductors to the abductors was:—

Adductors, 10.

Abductors, 10.5.

III. The number of cases of simple foot strain tested was forty-six. The ratio of the average strength of the adductors to the abductors was:—

Adductors, 10.

Abductors, 10.8.

IV. The number of cases of acute "flat-feet" tested was thirty-two. The ratio of the average strength of the adductors to the abductors was:—

Adductors, 10.

Abductors, 12.2.

If we accept these measurements therefore we may conclude that in the normal foot the adductor group is composed of muscles having a stronger combined pull than the abductor group. This latter group however, favored as it is in the position of weight-bearing by the planes of the joint surfaces, may become comparatively the stronger and favor foot strain, because it overbalances the adductor group. Conversely we may conclude that the weaker the adductors the more likely are the foot structures to be strained, and other things being equal the more severe will the subjective symptoms probably be.

The application of this method of measurement to treatment is simple.

Given a case of painful feet, it seems to us important to determine by some method more accurate than visual examination the condition of muscle balance. We may perhaps determine whether any brace treatment is necessary, and if so whether a rigid or a flexible

brace is advisable, or whether a Thomas heel may not be more properly employed. We may offer a more sure prognosis and watch the result from our protective treatment and the success of the exercise treatment which should follow.

In this exercise treatment we have again sought by resistive gymnastics to develop the whole adductor group. To many patients massage is impossible. We have also found it very difficult to ob-

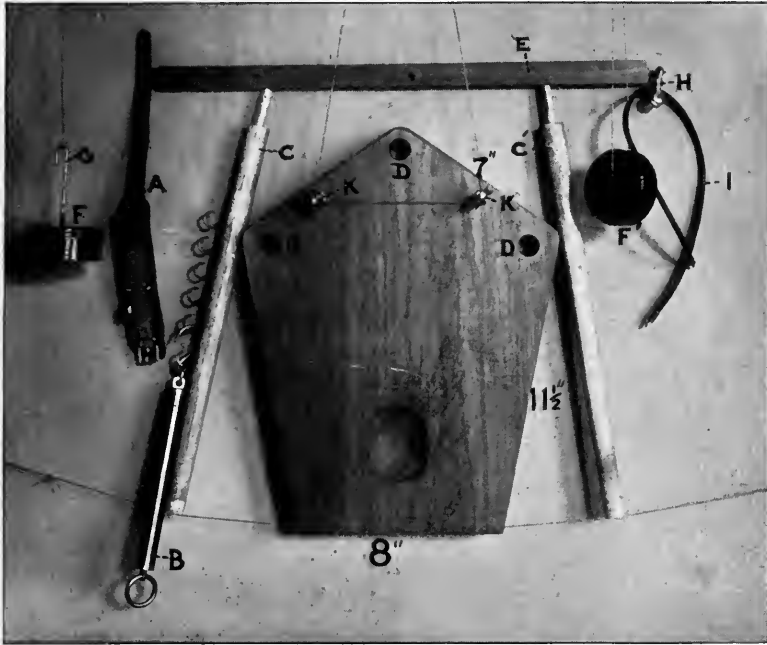


FIG. 260. Flat view of individual parts of foot exerciser.

tain satisfactory coöperation of the patient without some form of apparatus. An attempt has therefore been made to devise a simple, inexpensive, and portable machine which can be given to the patient for home use.

The exercises are taken with the patient seated. A detailed description is perhaps unnecessary on account of the accompanying cut. The dimensions however may be found useful.

A piece of two-inch plank is cut into the figured shape and of the dimensions indicated in the cut (Figure 260).

The uprights, C and C' (Figure 260),  $16\frac{1}{2}$  inches long over all, are made of  $\frac{7}{8}$  inch dowels and tapering slightly at their lower ends fit into ordinary auger holes, D (Figure 260). The cross-bar, E (Figure 260), with a cup hook at either end, is 19 inches long,  $\frac{7}{8}$  inch wide, and  $\frac{1}{2}$  inch thick, and is pierced by two holes to fit over the top pieces of the uprights: one hole is centred  $3\frac{7}{8}$  inches from one end and the other hole is  $9\frac{7}{8}$  inches from the same end (see apparatus set up, Figure 259).

Rough testing of the comparative strength of the adductors and abductors can be done by inserting the upright with hooks, C (Figure 260), into a hole on the side of the base-board centred  $7\frac{3}{4}$  inches from the posterior corner, and fixing the thigh manually or by cross-straps to the rounds of the chair. The tests are then made in the manner previously described.

The weights, F and F' (Figure 260), are made by pouring molten lead into sections of brass pipe  $2\frac{1}{8}$  inches in diameter. The thickness of one weight is  $\frac{7}{8}$  and of the other  $1\frac{1}{8}$  inches. These weigh two and three pounds respectively. In the larger is incorporated a hooked wire, G (Figure 260), over which the lighter weight slips as in the ordinary scale weight. The hanging pulleys, H (Figure 260), can be purchased in any large hardware store and twenty inches of round leather belting  $\frac{3}{16}$  inch in diameter softened with neat's-foot oil is used as the cord, I (Figure 260). A small wire loop is fastened to each end of the cord and retained by a brass ferule. With the weight hooked to the wire loop on one end, the cord is passed through the pulley hanging at the end of the long arm of the cross-bar and then by the loop at the other end caught into the catch-hook on the strap which encircles the foot. (See Figure 259.) With the heel in the cup-shaped depression, the foot is slowly inverted, the weight acting as a resistance after the manner of the commonly used chest weights. The toes should be forcefully flexed as the foot is adducted, thus exercising the flexor longus hallucis and flexor accessorius. The tibialis anticus is best developed by dorsal flexion, coupled with slight adduction. For this purpose the hanging pulley is placed at the end of the short arm of the cross-bar, and with the

weight on one end the cord is passed through this hanging pulley and through the stationary pulley, K (Figure 260), on the base-board. For the right foot the left pulley is naturally used, and vice versa. The other end of the cord is now attached to the foot-strap by the catch-hook, which is brought into the sole of the foot. With the knee extended the exercise of dorsal flexion and adduction is taken, the foot raising and lowering the weight.

For the other foot the cross-bar connecting the two uprights is removed, the posterior of the two uprights is changed to the hole on the other side of the base-board, and the cross-bar replaced.

As an exercise for the anterior arch, the patient is given several sizes of marbles, and instructed to pick them up with the toes and place them in the cup-shaped depression in the base-board. At first only small marbles can thus be seized, but gradually larger sizes are possible. The number of times they shall be thus picked up can be regulated for the individual case.

The results thus far from these regularly taken exercises have been satisfactory. The simplicity and cheapness of the appliance are its only merits. We believe that by some such method many patients may be more speedily freed from dependence upon plates and made to walk with a free and tireless gait.

A more elaborate and perfect mechanism is the machine of Fr. Baumgartel, alluded to above. With this apparatus it is possible not only to give appropriate exercises to flexible feet, but also, we believe, to limber many rigid forms.

Careful attention should be paid to the gait and poise of the body. The admonition which we probably all received from our own parents, to turn our toes out in walking, should be combated, and in its place lessons in a straight, toe-forward, springy gait and a correct erect attitude should be given.

We believe that in the future more orthopædic apparatus will be corrective, and less simply retentive. The principle of the spring is applicable in many cases, and gives results not to be obtained by rigid apparatus. The authors are of the opinion that all the conditions in which plates are needful in the treatment of weak and flat

feet cannot be met by any one form of support, and that therefore one should have several kinds of plates from which to select.

As an example: Plates made of light steel, carefully tempered, of 21-26 gauge, and covered with compress cloth, painted with several coats of an acetone solution of celluloid, are extremely durable and comfortable, giving relief to symptoms in the common mild cases of foot strain, and producing none of the atrophy and subsequent weakness which nearly always results from the rigid plate.

In certain cases, in which night supports are advisable, to increase adduction, a valgus shoe has been made, having a lateral hinge joint just below the antero-posterior stop joint. A spring is stretched from the front of the sole plate to the calf band, and thus dorsal flexion and inversion maintained by a constant pull, the strength of which can be regulated by the stiffness of the spring.

Proper shoes are the most important form of apparatus. Through coöperation of manufacturers and orthopædic men, several lasts, which are made on good non-constricting lines and are fairly flexible, are to be had ready-made. For the active hours of the day we should insist that shoes which favor slight adduction of the fore foot, and give wide space for toe action, should be worn.

## CHAPTER XIII

### ANEURISM

A CONSIDERATION of the diseases of the joints would be imperfect which did not include aneurism among those conditions which are capable of giving rise to joint symptoms but whose essential primary lesions are outside of the articulations in which symptoms are manifested.

There are several diseases which produce such joint lesions and that have had no adequate description in text-books. Perhaps the most notable instance of this is the abdominal aneurism. The joints which are thus affected are those composing the vertebral column, and it is of importance to remember that an antero-posterior deformity of the spine may be due to one of several causes. Any antero-posterior deformity occurring in the vertebral column indicates that there is some destruction of the substance of the vertebræ either through the crushing effects of traumatism or the results of disease. There are congenital deficiencies, but these will not be considered under this head.

The capacity for eroding bone which is possessed by an aneurism is well known. Symptoms of it are frequently seen in the thoracic aneurisms causing pressure upon the sternum and other portions of the thoracic skeleton. A common situation of the abdominal aneurism is at or about the celiac axis, and erosion of the vertebræ in this situation, though it may not go so far as to cause a caving-in of the anterior portion of the vertebral column, thus giving rise to a posterior deformity, may yet by its irritation of this region produce fixation of that portion of the spine which is in close relation to the aneurism. Indeed it is more frequently the case that antero-posterior deformity does not occur. An aneurism which has eroded the vertebræ to such an extent as to produce a decided deformity

would be likely to rupture or to produce such serious symptoms in the individual that the condition would be recognized. It is therefore the cases in which pronounced deformities have not occurred which are of most importance from the clinician's point of view.

As would naturally be expected aneurisms do not occur at the period of life when the most common of all the causes for antero-posterior deformity of the spine occur. The medical profession is not as generally conversant with the fact that Pott's Disease occurs in the adult as it should be, hence the confusion which is all the more likely to arise in a differential diagnosis between Pott's Disease and aneurism. The larger number of cases of aneurism occur between the ages of thirty-five and sixty. They are more frequent in men than in women. In fact, so far as the personal experience of the writers is concerned, no cases have been seen in women. The reason for this is that the causative factors which produce aneurism are not as prevalent among women as they are among men. Therefore, a rigid spine or a spine with a slight antero-posterior deformity occurring in a man of middle age should lead one to investigate the arterial system to see if there are any signs of thickening of the vessel walls, inequalities of pulse on the two sides, abnormal bruits in the course of the vessels, or tendency to unusual pulsation along the course of the arterial trunks.

A history of syphilis with signs of the sort mentioned above should lead one to be suspicious as to the possibility of an aneurismal cause for such symptoms. In thin people of course pulsation in the epigastrium and visible as well as palpable beating of the abdominal aorta is not uncommon, and extreme caution must be observed in determining whether there is any expansile pulsation to the supposed tumor. It must also be remembered that some of these aneurisms in this region are of the dissecting kind and are not definite tumors, which are palpable in the usual situation of abdominal aneurisms. One such instance occurred in the practice of one of the writers, and a relation of the principal points of the case may be of practical value.



The patient was an adult of 48 years, from whom no history of syphilis was obtained, and in whom there was very slight evidence of artero-sclerosis. The diagnosis of aneurism was not made however before operation. The patient was thought to be suffering from an hypertrophic process in the vertebral column. He had a great deal of pain referred to the lower back and groin and also radiating down one thigh. He was much emaciated, very anæmic, could sleep very little, and suffered during the day as well as the night a great deal of pain. Jackets were applied on the supposition that it was an hypertrophic arthritis and were persisted in in spite of the fact that very little if any relief was experienced from them. One day the patient, who was up and about the ward wearing a split jacket, suddenly fainted, and on first being seen by the physician in charge of the ward was nearly pulseless. On removing the jacket a palpable tumor was felt in the left hypochondrium which was evidently connected with the arterial system, and which was operated upon as an emergency by the surgeon who was on service in the hospital at the time. A dissecting aneurism was found originating at the coeliac axis, but the patient was beyond any surgical relief.

The characteristic physical signs of this condition are, as has been already intimated, rigidity of the spine with occasionally a slight amount of antero-posterior deformity, with almost invariably an obliteration of the physiological lumbar lordosis. When the aneurism is situated low in the dorsal or lumbar region, the pain is of a different character from that which is experienced in Pott's Disease or most of the other forms of spinal disease. Carcinoma is perhaps the only other condition the pain of which is at all comparable to that experienced by those who suffer from aneurisms. It is of a boring, gnawing character, constant or nearly so, and like most other painful sensations is aggravated at night. Sleeplessness and constant pain soon show their effects in the faces of the sufferers from this trouble and cachexia, anxiety, and pallor are commonly associated with the pronounced cases. The patients are frequently

emaciated, partly because of the discomfort and loss of sleep. Pressure upon the nerve roots causes referred pain in remote parts of the body, as in the case cited. Unilateral leg pain is not uncommon in aneurisms in this situation, though not as frequent as in some of the other causes of spinal rigidity.

The abdomen should be carefully palpated, and, as has been intimated, the existence of a pulsating aorta in a thin person must be distinguished from the expansile thrill associated with an aneurism. Differences in the pulse-rate in the femoral vessels are of value in determining the existence of aneurisms which occur lower down than the bifurcation of the aorta, but are of no service in the recognition of the purely abdominal aneurisms. The X-ray is of the greatest assistance, not only in determining the existence of this sort of tumor, but also in localizing it. Ability to distinguish between the aneurisms of the cœliac axis, of the renal vessels and of the aorta may enable us to relieve the patient permanently from such a condition by surgical procedures, inasmuch as aneurisms of the renal artery may be amenable to surgical treatment.

It has been the experience of the writers that in the inoperable cases some form of fixation to the spine is capable of giving these patients in certain cases a considerable amount of relief. A vertebral erosion, whether it be due to tuberculosis, aneurism, or any other destructive cause, is a painful condition which is aggravated by every motion made by or contributed to the vertebral column. It is therefore of assistance to support the spine by a plaster or leather jacket or by a back-brace.

The prognosis of course in cases of this sort is extremely grave. Unless the aneurism be situated in such region as has been suggested it is practically impossible to do more than slightly alleviate the patient's suffering.

We present the following typical case in which diagnosis was clear, cure impossible, and considerable relief was secured by support.

Mr. T. B. W. Age, 65 years.

First seen in consultation September 8, 1903. For two years he had been having a great deal of pain in the back radiating to the groin. Pain had been severe during the day, but until the last two nights he had been able to be fairly comfortable with narcotics. The last two nights he has been kept awake by pain referred to his chest as well as to the trunk and lower abdomen. No aggravation of pain on coughing or sneezing. Has lost from 35 to 40 pounds of flesh in the past two years. This loss does not at present seem to be a progressive one. Appetite is fair. Has had to take a great deal of morphia, to which he attributes the constipation from which he has suffered. Is wearing a leather jacket, which for the past three months has given him the most relief of anything that he has tried.

Physical examination. — Poorly developed man. Rather anæmic. Stands with marked stoop. A prominence of three vertebræ in the mid-dorsal region. Spine is stiff to motion in all directions. No kyphos. A little over half an inch expansion of the chest possible. In the epigastrium there is a mass the size of a large orange which pulsates and has an expansile thrill, evidently an aneurism.

Some months later patient suddenly died from rupture of the aneurism.

## CHAPTER XIV

### TABES MESENTERICA

FOR many years intra-abdominal glandular tuberculosis has been recognized as a clinical entity, and much study has been expended in attempts to determine the methods of infection in these glands. It has not been noted however that disease of these structures could cause irritative symptoms in the spine in a manner similar to that in which lesions of the mediastinal glands not infrequently produce torticollis. Recent investigation is making it more and more manifest that there are several conditions in and about the spine not associated with a kyphos which give rise to many of the cardinal symptoms of vertebral tuberculosis. The purpose of this chapter is to show that tuberculosis of the abdominal lymph glands may give rise to spinal symptoms; to distinguish symptoms produced in this way from similar symptoms produced by other diseases; and to suggest, though the absolute proof is wanting, that in some cases vertebral tuberculosis is caused by a direct extension from tuberculous abdominal lymph nodes.

The abdominal lymphatic glands may be divided into two chief groups, the mesenteric and the lumbar.

The former lie in the mesentery of the intestines, chiefly about its radix, intimately associated with the blood vessels. Their chief purpose is to pick out and to carry off the fatty portion of all ingested food, and their ramifications extend into the walls of the entire small intestine and of the greater part of the large intestine. They serve also as filters of the large expanse of mesenteric peritoneum and their efferent canals form the intestinal trunk.

The lumbar glands lie close to the lateral and anterior aspects of the vertebral column from the bifurcation of the aorta to the point of origin of the superior mesenteric artery. Aside from tributaries from the stomach and rectum they have no connection with the di-

gestive tract, but through the iliac, hypogastric, and sacral plexuses, which drain into them, and through their lesser tributaries, they serve as the final filters of lymph from the lower extremities, the bony and soft parts of the pelvis and lower part of the trunk, the pelvic and renal viscera, the peritoneal cavity, and the spinal canal. They maintain anastomotic connections with the thoracic glands, but most of their lymph is drained into two lumbar trunks. These, uniting with the intestinal trunk, form the so-called chylocyst, the dilation of the lower end of the thoracic duct.

With such extensive ramifications and diverse functions, the abdominal lymph glands are necessarily subject to a wide range of infection, and that by the tubercle bacillus is perhaps the most common. Although only occasionally diagnosed in life by careful examination or at operation, the post-mortem records show tuberculous involvement of these glands in a surprisingly large proportion of cases. In general miliary tuberculosis, these glands, together with the other lymphatic groups, are almost invariably enlarged, soft, and undergoing beginning caseation. Bacilli can be obtained from smears, and histologic examination shows typical tuberculous foci. In more chronic or localized tuberculous disease they are also frequently found involved, either as fluctuating, caseating conglomerations, or as inactive calcified masses, from which all glandular appearances have disappeared. Less frequently they present the only tuberculous lesion to be found in the subject, as in five cases, of a series of 120 fatal cases in children, coming to autopsy, in which the mesenteric glands were alone involved.

In infants and young children, tuberculous infections are for the most part first manifested in the lymphatic glands. In these cases, the mesenteric and the bronchial glands show tuberculous foci in the majority of the fatal cases.

Such investigators as Simmonds, Batten, Colman and Carr found the bronchial glands involved in three-fourths of their cases, and the mesenteric in half, while Woodhead placed the latter as high as 80%. In adults, tuberculous infection more commonly occurs through the respiratory tract, and, therefore, involve-

ment of the lymph glands is not so frequently found in these cases.

Morf, in a series of 232 consecutive adult autopsies from the Rush Medical College, in which careful examination of the abdominal lymph glands was carried out, found them involved by tuberculosis in nine cases, about 4%. König, in a similar series of 2230 autopsies, found them involved in nearly 2%. The records of 1000 consecutive autopsies at the Massachusetts General Hospital, examined by the authors, through the courtesy of Dr. J. H. Wright, showed tuberculous lesions in some portion of the body in 182 cases. Of these, 55 cases showed tuberculosis of the bronchial, and 41 of the abdominal lymph glands. These cases, almost all of which were in adults, show the condition to be fairly common.

#### SOURCE OF INFECTION

There are three chief sources of tuberculous infection of the abdominal lymph glands: (1) Direct extension from adjoining diseased tissues. (2) Infection from the blood stream. (3) Infection through the lymphatics.

The first is uncommon and of minor importance. The second, or infection from the blood stream, is not infrequent. When small numbers of bacteria invade the glandular tissue they are, as a rule, promptly destroyed, without symptoms, and with little or no damage to the glands themselves. In severe infections the process is general in its nature; there is involvement in all the lymph-gland groups, and miliary involvement of the viscera. Here the course of disease is acute, and death follows shortly. The autopsy shows all the lesions, save the old primary focus, to be of an acute character. The third source of infection is through the lymphatics which carry the filtered bacteria to the glands and deposit them there. This is the usual picture presented in tuberculosis of the abdominal lymphatics, and is almost invariably the mode of infection in the more or less chronic and isolated gland lesions.

In young children the infection is usually from the alimentary

tract, and the mesenteric glands are the groups most frequently involved.

That bacteria may pass through an intact intestinal membrane, leaving no lesion behind them, and thus enter the lymphatic system, seems to be definitely proved by careful post-mortem investigations and animal experiments, while histologic examination shows that often the leukocytes which pierce the walls and follow the course of the lymph channels to the glands are the carriers. Infection, though possible under these normal adverse conditions, is doubtless more prone to occur when the intestinal resistance is lessened by a mild chronic catarrhal condition, so common in children, or by some other lesion.

The posterior lumbar groups are more frequently subject to infection from tuberculous pelvic organs or vertebral disease. This last source, though mentioned over fifty years ago by Bamberger, has been but little noted.

#### COURSE OF DISEASE

A lymph gland, in which a focus of tuberculosis is present, remains always a source of danger to the rest of the body. The gland, which no longer functions but has become a cystic conglomeration of tuberculous detritus, may undergo tuberculous calcification, and the focus be permanently walled up, but even in these cases the organisms may remain alive indefinitely. That this is a common termination is shown in numerous cases by subsequent examination, either at operation or autopsy, when this unsuspected lesion has been revealed.

Frequently however the process finds soil more suitable for its growth; there is rapid involvement and enlargement of one gland after another by means of the connecting lymphatics, until the abdominal cavity is filled to a great extent with masses of glands which crowd the intestines into small compass, or involve them in a maze of adhesions. The process is often gradual in its onset. For months, or even years, there are but slight or occasional symptoms, chiefly dull pains persisting for long intervals, and deep, localized tender-

ness. The symptoms gradually increase in frequency and severity. The abdomen becomes distended and ascites develops, due to pressure on the great vessels, or jaundice follows partial closure of the bile ducts. Marked cachexia results from interference with the function of the intestinal lymphatics, intestinal disturbances become more marked as a condition of chronic obstruction appears, and usually late in the disease large irregular masses in the abdomen are easily palpable. Such is the so-called tabes mesenterica, of which the termination is death from inanition and toxæmia.

### COMPLICATIONS

Often the glandular involvement is more or less localized, and it is to complications that the fatal termination is due.

(1) *Intestinal obstruction*.—Complete intestinal obstruction, both chronic and acute, is not infrequent, following simple pressure on the intestinal wall from the glandular mass or as a result of stricture due to adhesions binding intestines and glands into an inextricable mass. Much less frequently occlusion follows secondary involvement of the wall of the intestine itself.

**Case I.** A young man of 23 entered the Hospital Clinic, having suffered for some time with pain in the lower part of his back and weakness in his legs and tendency to contracture of the same. The abdomen was quite rigid and numerous accumulations of glands could be felt in various parts of the abdomen. Patient had lost weight, was rather anæmic, and seemed to be suffering a great deal. The spinal motions were restricted in all directions, though there was very little discomfort on attempts to move the column. An exploratory laparotomy was performed in order to see if it were possible to remove any considerable number of the glands, and it was found that they were so extensive, so matted together, and groups of them were on the point of breaking down, that the abdomen was closed and nothing was done. The psoas contractures increased until the thighs were flexed on the abdomen to a right angle. Accumulations of glands in both groins and both loins



finally broke down and either spontaneously evacuated themselves or had to be opened. The patient suppurated profusely from two sinuses in front and two in the back, and gradually failed in general condition. All attempts at treatment were abandoned both by the family and the attending physicians, as it seemed inevitable that the boy should die, and nothing that was offered afforded him any relief. About three years after this the patient called at the office of the writers to make application for reinstatement in the Navy Yard, where he had worked previous to being taken ill. He had gained something over eighty pounds in weight, and seemed the picture of health. The abdomen was entirely soft, and no glandular masses were to be palpated in any portion of it. The sinuses had been healed for upwards of a year and the spinal motions, which formerly were considerably restricted, were entirely normal.

At the present time (July, 1909) he is baggage master for one of the transatlantic lines and is perfectly well except for occasional slight suppuration from his old sinuses.

(2) *Peritonitis*. — The glandular cyst-like masses may reach enormous size, and here the danger of rupture presents itself, the sac evacuating its contents in the line of least resistance. If this be through the peritoneum, a local or general peritonitis follows, the latter quite frequently, and usually terminating fatally. Cases in the literature show direct rupture into the cavity and the presence of varying amounts of tuberculous pus to have been the cause of the resulting peritonitis, though theoretically there may possibly occur a back flow in the lymph channels between the glands and the peritoneum, bringing about a similar result.

(3) *Formation of abscesses progressing outward*. — Frequently the encysted collection of tuberculous detritus, instead of rupturing into the peritoneum, follows the general course of the psoas abscess, and points either in the loin or in the thigh below Poupart's ligament, when it ruptures spontaneously. There may be no rise of temperature, but pain and limitation of motion in one or both hips may

follow irritation of the psoas muscle. Pain in the thighs or calves due to pressure upon the posterior nerve roots is also not infrequent.

### DIFFERENTIAL DIAGNOSIS

Pathologic conditions in the abdomen simulating tuberculosis of the mesenteric glands have been too fully described to need further mention, coming, as they do, in the field of the abdominal rather than the orthopædic surgeon.

Among cases with spinal symptoms, mesenteric tuberculosis must be differentiated from Pott's Disease, aneurism of the abdominal aorta, malignant disease, especially cancer, osteoarthritis, osteomyelitis, and other inflammatory diseases in or about the spine.

**Vertebral Tuberculosis.** The presence of a definite vertebral kyphos is ordinarily pathognomonic of Pott's Disease, though the two conditions may be co-existent. In children and young adults the appearance of a kyphos almost always reveals the true diagnosis very early in the process. In the adult, however, sufficient symptoms occur prior to the deformity to lead the patient to seek advice, and in such cases the following points aid materially in distinguishing between the glandular and the osseous types of disease:

The rigidity of the spine in cases of true osseous involvement is much more sharply defined than in cases due to pressure from outside. The restriction in vertebral tuberculosis is uniform in all directions and is evidently spasmodic and in no way mechanical, as in other conditions. Limitation of motion is most evident in flexion. Lateral bending is less markedly but symmetrically impaired. The abscess accompanying vertebral disease is usually a definitely sausage-shaped tumor conforming to the shape and direction of the psoas muscle, in the sheath of which it lies. The glandular abscesses lie anterior to the psoas, and, in consequence, point very infrequently in the back. Irritation and contraction of the psoas, though common in the glandular abscesses, result only from direct pressure of the abscess upon the muscle. Glandular abscesses also tend to close much earlier than do those from an osseous focus, because single

glands or small groups of glands oftentimes break down without carrying with them the entire lymphatic chain of that region. Here, too, pain and discomfort are much less than in the cases of osseous disease, as a rule, and it is not until extension takes place to the bone that pain becomes pronounced. The night pain of bone tuberculosis is a conspicuous feature, which is absent in the glandular cases; in the latter, pain is frequently referred to the thighs, most commonly to both. The constitutional impairment of the type of glandular tuberculosis giving rise to spinal symptoms, as distinguished from that produced by the true *tabes mesenterica*, is generally not so grave as is ordinarily caused by an osseous vertebral tuberculosis. The final test to be applied is that of a good Röntgen ray, which should, in those cases in which the disease is below the eleventh or twelfth dorsal vertebra, show evidence of a positive character, either as regards the osseous or the glandular process.

*Neoplasm.* — Malignant disease of the spine in the adult is usually carcinoma, and is rarely, if ever, primary in the vertebræ. The primary focus is usually in the breast or in the intestine. A few cases have been observed in which the diagnosis was made provisionally and positively confirmed by autopsy. The chief difficulty lies in the differentiation from an osteo-arthritic process, since the clinical picture of asymmetric spinal limitation, with the absence of kyphos and of abdominal signs, is strongly suggestive of both diseases. In one case, that of a young woman, this doubt was removed when it became known that a breast had previously been amputated for cancer, and furthermore, a Röntgen ray of the spine showed the malignant character of the process. The second case was in an elderly physician, whose excruciating pain was not relieved by fixation; he progressively lost ground, became more and more cachectic and emaciated, and finally succumbed. The primary focus was found at autopsy to be situated in the head of the cæcum. Pain in vertebral carcinoma is deep-seated, and does not usually radiate. It is little relieved by fixation; is attended with progressive emaciation and cachexia, and usually occurs in elderly people. Sometimes a slight antero-posterior deformity occurs. Numbness and prickling

in the feet and legs are occasionally noted. Sensory peripheral disturbances are more marked than motor.

**Osteomyelitis.** — Osteomyelitis of the spine is a comparatively rare condition. There should be no difficulty in differentiating it from tuberculous abdominal lymph glands, if seen in the acute stage of the process, and the history should establish the diagnosis at once in chronic cases. The general condition of the patient with acute osteomyelitis is very striking. The picture is that of a more or less profound septicæmia with a rapid onset, high temperature, acute pain, early and rapid abscess formation, rarely any kyphosis, rigidity of spine to all motion, due to muscle spasm. The character of the abscess is that of an acute pyogenic infection, with redness, heat, bogginess, and great tenderness. The abscess may point posteriorly, or appear in the pelvis, suggesting an appendicular abscess, as in one case seen in the hospital. In this case operation showed it to be subperiosteal, and it was drained through a lumbar incision.

**Osteoarthritis.** — The hypertrophic form of arthritis occurring so frequently in the spine has many features in common with mesenteric glandular tuberculosis. The patient's general health is seldom if ever impaired. Spinal motions are restricted, and there is no localized kyphos, but a permanent antero-posterior or lateral curve of the entire column may be present. Restriction of motion is asymmetric, and varies in character at different levels of the column. Pain is rarely very severe, and if the spinal limitation is in the lumbar region, unilateral leg pain is common. This is usually referred to the back of the thigh and calf. Atrophy of the gluteal region, and of the thigh and calf on the affected side is very common, and is not an atrophy of the muscles, but seems to be of the skin and subcutaneous tissue. There is no abscess formation in this disease. Adequate fixation gives prompt relief. If the disease is above the lumbar region, restriction of respiratory excursion is common.

**Infectious Arthritis.** — The infectious processes which attack the other articulations of the body may involve those of the vertebral column with similar results. Usually only the supporting ligaments

are involved, but in some cases erosion of cartilage or even destruction of bone may occur, with resulting ankylosis. In the milder infections, when no erosion occurs, the spinal ligaments and the capsule of the intervertebral articulations become infiltrated and the whole column becomes rigid. As the acute process subsides, motion returns in varying degree. The clinical picture of this disease is distinct from that of any of the other processes which cause partial or complete rigidity of the spine. The entire column is usually involved, and a rounded total kyphosis is common. No motion is permitted in any direction. The onset is commonly acute. Respiratory excursion is entirely obliterated in some cases.

**Spinal rigidity from intra-abdominal inflammatory conditions.**

—Among the intra-abdominal inflammatory conditions which may produce rigidity of the vertebral column are appendicitis, inflammations of the gall bladder, subdiaphragmatic, nephritic and perinephritic abscesses. Mild cases of inflammation of the appendix may be confused with retro-peritoneal glandular tuberculosis. In both cases there is a varying amount of rigidity of the abdominal wall, and although tuberculous glandular involvement is usually accompanied by little elevation of temperature, the same condition is often present in chronic appendicitis, even when considerable tissue destruction has occurred.

The presence of abscess formation resulting from either chronic non-tuberculous or tuberculous glandular involvement, when situated in the right hypochondrium (the location in the majority of our cases), usually causes rigidity of the right rectus and impairment of spinal motions, especially toward the left. One must bear in mind, therefore, the possibility that an appendicular abscess may cause spinal limitation in addition to the symptoms which are wont to be regarded as pathognomonic of the condition. Similarly, inflammations of the gall bladder may be the cause of spinal rigidity, resistance to pressure on the right side of the abdomen, and of a mass palpable in a region not inconsistent with the distribution of the retro-peritoneal glands. It is however rare that the distinguishing symptoms of either appendicitis or gall bladder inflammation

are not present in addition to those mentioned, and they must be carefully searched for, before arriving at a positive diagnosis. Inflammations in the upper abdomen or in the pleural cavity which penetrate to that section of the abdomen immediately beneath the diaphragm are also capable of producing spinal rigidity, abdominal rigidity, and palpable tumor masses in the upper abdomen. Therefore one may occasionally have to exclude the cases of subdiaphragmatic abscesses in his differential diagnosis.

The writers have previously referred to the necessity for differentiating spinal inflammation from inflammation of the kidney substance, and it is not infrequently the case that large perinephritic or nephritic abscesses may occur, the pressure of which so irritates the muscles having their origin or insertion in the vertebral column that they draw it toward the seat of inflammation, which is outside of the column itself. The evidence of nephritic abscesses must then be sought for, that one may not fall into the error of overlooking this condition when spinal symptoms seem to be the conspicuous features.

### TREATMENT

The treatment of inflammations of the abdominal lymph glands may be divided into three parts:

(1) **General.** As in all tuberculous processes, the general constitutional treatment is perhaps the most important, and all the factors which contribute toward the building up of the general system, enabling the patient to counteract the effects of the tuberculous infection, are to be encouraged. Outdoor life, freedom from labor, extra diet, and such drugs as contribute toward the stimulating of the appetite and the regulating of all bodily functions are to be resorted to. Aside from this, medicinal remedies are of no particular value.

(2) **Mechanical treatment.** Many conditions which do not directly involve the spine nevertheless require fixation of that structure in order to give relief from pain. This undoubtedly is due to the flexibility of the vertebral column. Free motion of the spine may

easily act as a constant irritant to diseased retro-peritoneal glands. Therefore, patients with glandular disease within the abdomen in whom there has been no evidence of an osseous process are usually sufficiently benefited by the application of jackets or the wearing of spinal supports of a less rigorous character to make it worth while to have them adjusted. The relief, of course, is not as marked as in the cases in which involvement of the spinal column itself has taken place. On the other hand, the painful symptoms of mesenteric tuberculosis are conspicuously less permanent than they are in tuberculosis of the column itself.

(3) **Operative treatment.** Ordinarily a portion of the abscesses which result from inflammation of the abdominal lymph glands become absorbed and give no further symptoms. In certain cases a small portion of the total number of glands which have become involved break down. These may discharge through the abdominal wall or point in the thigh or at Poupart's ligament, the discharging sinus usually closing much sooner than when associated with an osseous process, as one would naturally expect. In the early stages of the involvement of these lymph glands they are discrete, but as the process continues they become matted together, and the products of inflammation fuse large areas of glandular tissue into solid masses. If aggregations of glands thus matted together break down, the course of the abscess may simulate in its duration the course of abscesses derived from osseous foci. Much the same rules hold good for the treatment of abscesses derived from broken-down lymph glands as obtained in the treatment of abscesses from tuberculous bone lesions. It is very important to prevent them from becoming secondarily infected, and therefore incision should be delayed as long as possible. Aspiration, when they are so situated that this may be done without danger of puncturing overlying or neighboring viscera, is preferable to open incision. If any positive or even strongly presumptive evidence can be adduced to indicate that the glands are isolated and small in number, it is possible to resect them through an open incision. This, however, is rarely done, principally because, as a rule, the number of glands is greatly

in excess of what might be anticipated, and too extensive a section of mesentery and intestine would be necessary, and partly because of the astonishing capacity for the absorption of these glands which is possessed by the human organism. In the case here reported the writers found at operation an abdomen filled with glands in all stages of the process, but for the most part so broken down and matted together that resection was impossible, and the abdomen was closed without any attempt at removal of the mass. In the course of two years the patient was again seen, at which time there was absolutely no evidence from external examination of a pathologic condition of his abdomen. There were no nodules to be felt, no spinal or abdominal rigidity, and the sinuses had been closed for a long time. Several other cases have been reported by Petersen, in which equally good results followed a simple celiotomy in similar conditions. In numerous other cases simple incision and drainage have been performed with varying results.

#### PROGNOSIS

The prognosis of inflammations of the abdominal lymph glands is good as compared with that of vertebral tuberculosis in the same class of patients. The most serious features of the disease are extension to and involvement of the vertebral column, rupture into the peritoneal cavity, and intestinal obstruction, in consequence of the pressure upon coils of intestine or the matting-up of such coils in the products of inflammation. Aside from the gravity of these three complications the outlook for a patient with enlargement of the abdominal lymph glands is comparatively good. Much can be done to favor the prognosis, according to the extent to which it is possible to provide efficient treatment, and according to the degree to which the patient can be made to appreciate that he has to contend with a tuberculous lesion, which requires patience and perseverance second only to that required in the treatment of vertebral tuberculosis.



## CHAPTER XV

### SUBDELTOID BURSITIS

INFLAMMATION of the bursa beneath the deltoid muscle is quite common. It is probable that the majority of "periarthritic" inflammations of the shoulder are examples of this condition. The chief clinical characteristics of this affection are pain in the shoulder and upper arm, together with impairment of function at the shoulder joint. Traumatism in one form or another is the usual cause of these symptoms. The most common injury producing them is a fall upon the shoulder or a violent twist or wrench to this articulation. These constitute the direct traumatic causes of subdeltoid bursitis; next in importance are the traumatisms resulting from the habitual slight injuries connected with one's occupation; most rare of all are infections of this bursa resulting from the local action of a systemic toxin. There are occasional instances of what seem to be manifestations of osteoarthritis in this region, with or without evidences of a similar condition elsewhere.

The cases which are herewith reported demonstrate very strikingly the influence of the two forms of injury to which reference has been made.

Codman <sup>1</sup> has published a very careful anatomical study of the relations of this bursa to the structures about the shoulder joint and has called attention to the fact that in some cases there is a rupture of the tendon of the supra-spinatus muscle associated with injuries to this bursa. The bursa is situated immediately beneath the fibres of the deltoid muscle and directly above the fibrous capsule of the shoulder joint. In a normal condition it is very thin-walled, and adapts itself accurately to the different positions of the head

<sup>1</sup> E. A. Codman: "On Stiff and Painful Shoulders. The Anatomy of the Subdeltoid or Subacromial Bursa and its Clinical Importance. Subdeltoid Bursitis." *Boston Medical and Surgical Journal*, May 31, 1906, p. 613, and October 22 *et seq.* 1908.

of the bone as it changes with motion of the humerus and scapula. It is said by Codman to be aided in this adaptability by the contracture of the muscle, the tendon of which he has found ruptured in traumatisms to this bursal sac, and he attributes its liability to injury, in part, to the fact that rupture of this tendon does not permit the bursal walls to be pulled up out of harm's way when the humerus is elevated. Under normal conditions it must contain very little fluid. In size it perhaps encloses an area as large as the palm of the hand. The position of this sac can be well understood by looking at Figure 264. The incision shown in this case opened into the sac at the juncture of its outer and middle thirds and quite near its inferior border.

#### PATHOLOGY

The changes which take place in the walls of this sac consist of a thickening of the entire membrane in some cases, with a partial or complete obliteration of the cavity within. Sometimes villous enlargements have been seen in small areas of the sac so dense as to give a definite shadow in the X-ray, though there was no demonstrable deposit of lime salts associated with these villi. In one of the two cases in which the duration of the symptoms extended over a period of twelve to fifteen years, the sac was full of a yellowish, finely granular, cheesy material, having much the appearance of the contents of a wen. The second case in which this condition within the sac was present was very chronic, the patient having had more or less trouble for ten or twelve years. Chemical analysis of the content of the bursa in this case, made by Dr. E. A. Austin of Tufts Medical School, showed the following result: "The specimen contained a small amount of albumin which was soluble in a 10 % ammonium chloride solution and probably consisted of both serum albumin and serum globulin. A small amount of fat which was extracted by ether showed a very large amount of ash. This ash contained a small quantity of sulphate of potash, but over 90 % of it was made up of calcium carbonate and calcium phos-

phate, of which the latter greatly predominated. There was a small trace of magnesia."

In all three of the operative cases to be reported the X-ray examination has shown a very definite shadow in the region where the bursa was found. In two of these the sac was filled with cheesy material, in one of which, according to the above analysis, there was an excess of calcium carbonate and calcium phosphate, both of which substances would naturally obstruct the passage of the X-ray.

In Case I however there was no accumulation of cheesy material within the bursa, the walls of the sac being uniformly thickened throughout, and the cavity largely obliterated. The X-ray shadow was quite as dense as in the other two cases. In Case II there was practically no obliteration of the sac and the thickening of its walls was confined to the upper and inner and to the lower and outer corners. It was in these places that the X-ray revealed a shadow. It would appear that calcareous or cheesy change is a degeneration which may take place in the more severe injuries of the bursa in which adhesive inflammation has occurred, obliterating the cavity of the bursa and therefore destroying its function.

#### CLINICAL COURSE AND PHYSICAL SIGNS

In the cases brought on by direct violence the symptoms attributable to the bursal inflammation are necessarily somewhat masked at first by the immediate effects of the trauma. Occasionally, however, when the immediate effects are insignificant the true symptoms of the bursitis develop several days after the injury. This is probably always the case, though it is impossible to demonstrate it.

In the occupational cases the development of symptoms is necessarily much more insidious. Periods of comparative freedom from symptoms alternate with periods of severe pain, differing in this respect from the usual acutely traumatic case, where the maximum of severity is attained early and fluctuations are not as common. A dull ache associated with stiffness of the shoulder are the early

subjective signs in the majority of instances. Severe, knife-like pain is complained of by a considerable number of patients and its distribution is over the front of the shoulder joint, radiating down to the insertion of the deltoid and even as far as the forearm and fingers.

Restriction of the motions at the shoulder is early noted, those first affected being lateral elevation (abduction) of the arm and rotation. Forward flexion and backward flexion (extension) are preserved rather longer than the other motions, probably because the scapula will move with the humerus in those motions; it is sometimes difficult to determine just when independent humeral motion ceases. Great difficulty is experienced by these patients at night. It is almost impossible to assume a comfortable position because of the dragging back of the humerus when in the supine position or when lying upon the well side; lying upon the affected side is usually out of the question.

The physical signs do not vary greatly. The contour of the shoulder is not conspicuously altered. In the more chronic cases there may be more or less atrophy of the muscles about the shoulder, particularly the deltoid and the supra- and infra-spinatus. Occasionally a slight swelling may be seen localized over the bursa, and in one instance there has been a slight elevation of the surface temperature over the bursal enlargement. Acute, localized tenderness to pressure is a very constant symptom and this is demonstrable over the location of the bursa at a point close to the position of the scar seen in Figure 261.

Restriction to motion, both active and passive, is the most constant and important sign. There are exceptions, however, to this rule. One of the patients in whom calcareous changes had taken place, could make nearly all of the motions of the arm readily, except when she had an acute exacerbation. Muscular spasm restricts all attempts at passive motion as well as prohibits active motions. Pain is aggravated by voluntary motion. Fixation of the shoulder, the erect position or support with pillows under the arm and shoulder will give some relief from pain.

## TREATMENT

The manipulative treatment of the early or subacute cases under an anæsthetic, followed by frequent passive motion and massage, accompanied, as soon as lack of sensitiveness will permit, by active stretching exercises, gives good functional results after a few weeks or months of treatment, according to the severity of the case.

The open incision and removal of a large part of the sac should be practiced upon most cases, be they occupational or traumatic, which have lasted for six months or more. If they have caused trouble for as long a period as six months, they will require, even after a thorough manipulation under ether, a very long time to regain normal motion, if indeed they ever recover completely.

Restitution of normal motion has been accomplished with much less effort and very much sooner after the dissection of the bursa than after the most satisfactory ether manipulation which we have seen. Two physicians operated upon within the past year and a half have been able to return to their practices within three weeks from operation. In no instance do we recall a manipulated patient whose recovery has been so complete or who has been able to perform his duties so soon.

The operation is very easily performed. The fibres of the deltoid muscle are separated in a direction parallel to their long axes and the bursa is found very easily beneath the sheath of the muscle if the walls are at all thickened. If this is not the case it sometimes requires a little dissection to find it. The thickened portion of the bursa should be thoroughly removed by scissors dissection and the fibres of the deltoid loosely drawn together with two or three catgut sutures the sheath of the muscles being closed over it before suturing the skin. Care should be taken not to make the incision too far out on the point of the shoulder, and it should be made in women so that the shoulder-straps of a low-necked gown will cover the scar. It is better to close the skin with buried silkworm gut, but if the incision is too far out where the contour of the shoulder becomes

dome-shaped the skin is inclined to gape open, even though the suture be ever so nicely placed. (Figure 261.)

A Velpeau or a double sling applied over the sterile dressing gives good fixation and is comfortable. The suture is removed after a week or ten days and passive motion is immediately commenced. Hot fomentations to the shoulder favor the limbering-up process and

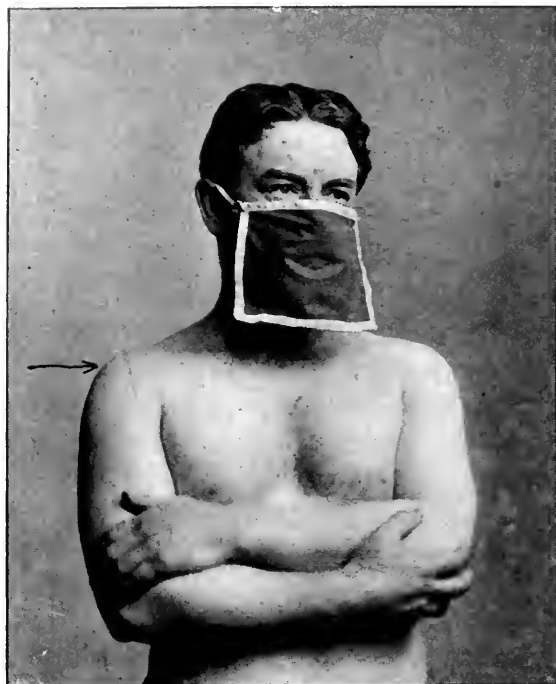


FIG. 261. Illustrates the position of the incision for the removal of the bursa and approximate location of bursa.

our experience has been that passive motion is restored to the normal in from three weeks to two months, whereas active motion is a little more tardily secured. Pain, except that which is associated with the limbering-up process, is almost immediately relieved.

Prognosis in this class of cases the writers are led to believe from their experience with both the manipulative and open methods of treatment is better through the open method than through simple manipulation. The shoulder joint is not opened; ether has to be

given in either case, and the risk of the incision is only the risk of superficial sepsis. The operation is not a long one if the bursa is dissected out, so that any subject to whom it is proper to administer an anæsthetic is in all probability a proper one upon whom to perform the open operation.

Convalescence is much shorter after the open method and the functional results are believed to be considerably better. The writers



FIG. 262. Arrow indicates location of thickened bursa.

are of the opinion that there is no advantage in putting the arm and shoulder up in a plaster spica in a strongly abducted position.

Two cases are reported in detail in order to illustrate the types described in the text.

**Case I.** G. P., age, forty-five.

On August 28, 1906, patient was examined because of a painful right shoulder which had been troubling him for about a year.

He is an active professional man, and finds that the discomfort is so great and the interference with the function of his right arm is so decided that he is seriously inconvenienced in the practice of

his profession. Apart from a susceptibility to "grippe" and rather frequent attacks of naso-pharyngeal catarrh, he has had no infections related to the present trouble. He has never had rheumatism, and he himself attributes the present symptoms to the jar of driving a Knox automobile. The pain commenced in the shoulder and extended down to the insertion of the deltoid muscle, and occasionally as far as the hand. It has been a considerable annoyance to him at night because of difficulty in assuming a comfortable position. It has been hard for him — in fact, impossible a good deal



FIG. 263. Arrow indicates situation of thickened sac.

of the time — to put on a heavy overcoat unassisted. There have been periods of relative immunity from pain during this past year, but there has constantly been some restriction in motion.

At the present time motion of the humerus independent of movement of the scapula is absolutely prohibited in every direction. There is moderate atrophy of the deltoid and trapezius muscles and also of the supra- and infra-spinati. Over the point of the shoulder is an area about the size of a twenty-five-cent piece which is exquisitely tender. There is no increase in the surface temperature. The



X-ray shows a definite shadow, as is seen in Figures 262, 263, and 264.

September 8, 1906. Under ether an incision 5 cm. long was made directly over the apex of the right shoulder. (Vide Figure 261.) The fibres of the deltoid were separated, the capsule exposed and between the inferior surface of the muscle and the capsule of the joint was a bursal sac which was uniformly thickened throughout its entire extent and was about three times as dense as it should be. There was evidence of an adhesive inflammation within the sac



FIG. 264. Arrow indicates location of bursa.

practically obliterating two-thirds of the entire cavity. There was no excess of fluid and no villous thickening of that portion of the bursal sac which was not adherent. The entire bursa was dissected out; the muscles were drawn together with interrupted catgut sutures; the skin was closed with a buried silkworm gut and the arm was restrained in a Velpeau. Previous to the application of the dressing, the humerus was moved throughout the entire arc of motion of which it was capable, in order to break up any possible adhesions. The patient was discharged from the hospital at the

end of three days; the stitch was removed at the end of a week, and passive manipulation of the arm very soon restored its function. The patient was engaged in his practice again within two weeks from the time of the operation, and the photographs (Figures 265 and 266) show the possible motion of the joint at this date, December 31, 1906.

December 31, 1906. — The patient reports that function has

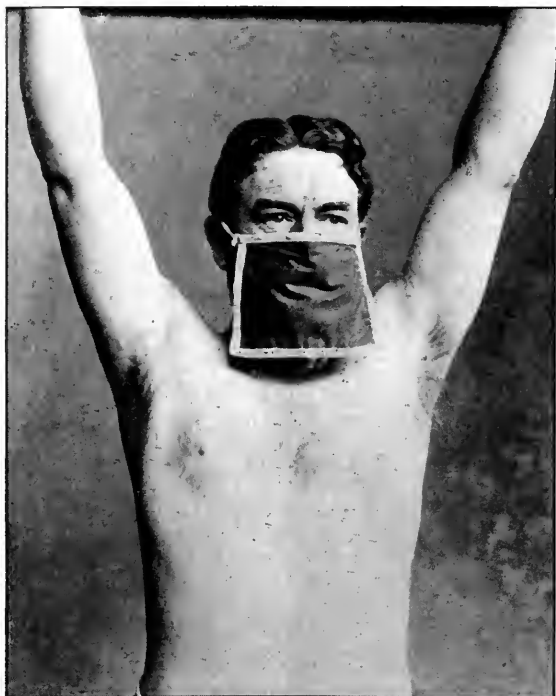


FIG. 265. Shows voluntary lateral flexion of the arms after operation.

been entirely restored and that there is practically no discomfort attending any motion he desires to make.

Owing to a delay in getting the tissue removed from this case to the pathologist, it was not in a proper state of preservation for histological study. This patient had an acute inflammation of the bursa beneath the left deltoid muscle about 9 months after the right one was operated upon. The arm was fixed, pain was intense,

and patient demanded surgical interference. This bursa was found acutely inflamed and was partially removed. Recovery of motion has been quite prompt and pain immediately ceased.

**Case II.** Mrs. B. L. S., age, thirty years.

On December 24, 1906, the patient was examined with reference to her left shoulder.

Three years ago, up to which time she had never had any injury to the shoulder and no trouble of any sort connected with it, the arm was severely wrenched, causing considerable pain at the time.



FIG. 266. Shows voluntary powers of lateral flexion and internal rotation of the humerus after operation.

This happened late in the afternoon. That night she was awakened after an hour or so of sleep by a severe pain in her shoulder. She discovered that the arm and shoulder were swollen and the pain was extremely acute. It lasted for approximately two weeks, gradually disappearing to return at varying intervals during the past three years. The recurrences have generally been associated with some excess in the use of the arm or some unexpected or unusual motion. They have lasted from a few days to two or three weeks, according to the severity of the injury. The last one occurred about ten days before she was examined, and the acute symptoms which had been connected with this injury had very largely subsided.

The pain radiated down the arm from the shoulder joint, being worse at the insertion of the deltoid. During the exacerbations of pain the motion of the shoulder has been materially interfered with and attempts to put the humerus through the normal arcs of motion have been associated with an aggravation of the pain.

On examination, the shoulder motions were not markedly restricted in any direction, but a distinct click could be felt in the region of the subdeltoid bursa when the arm was inwardly rotated, and also occasionally, though not as constantly, when it was forward flexed. These motions were accompanied by considerable discomfort. There was no local swelling in the region of the bursa; no increase in the surface temperature and only a slight amount of atrophy of the shoulder and arm muscles.

In Figure 263, the shadow in the X-ray indicates the situation of the bursa.

January 1, 1907. — Under ether an incision of approximately 5 cm. was made over the apex of the left shoulder, which exposed the bursal sac at a point about halfway from the apex of the shoulder to the inner border of the bursal wall. In the extreme outer and anterior portion of this sac was some villous thickening of the capsule, and a similar thickening was noticed in the inner posterior portion. Between these two points the bursal wall was of about normal thickness, and there was a slight excess of fluid present. This was thin and watery, but bore no indication of being inflammatory. There was no calcification of the thickenings above noted. The inflamed portion of the bursa was dissected out, the wound being treated, and the arm restrained as in Case 1.

January 8, 1907. — The stitch was removed; wound had healed by first intention, and about two-thirds of the normal arc of voluntary motion was possible in the shoulder joint.

The histological report upon the tissue removed from this case, made by Dr. Leary of the Tufts Medical School, is as follows:

Microscopic examination shows tissue to consist of bursa surrounded by striped muscle, fat and dense fibrous tissue.

Bursa is lined by a layer of epithelioid connective tissue which

varies greatly in thickness and is thrown into papillary folds. In places this tissue encloses aggregations of lime salts in the form of granules which vary in diameter from 10 to 15 microns. In part these granules are surrounded by collections of giant cells, in part they lie directly in contact with the mononuclear cells of the epithelioid layer.

There is an occasional lymphoid cell in the epithelioid tissue and rare polynuclears.

## CHAPTER XVI

### ROUND OR STOOP SHOULDER. CONGENITAL ELEVATION OF SCAPULA. FLEXED SCAPULA. SUBDELTOID AND SUBCORACOID BURSITIS. RECURRENT DISLOCATION OF SHOULDER. BRACHIAL NEURITIS OR NEURALGIA

**Round or Stoop Shoulder.** Of the various deformities which are met with among people of civilized communities one of the most common is that which is designated by the terms "round shoulder," "stoop shoulder," or "droop shoulder." In childhood this condition concerns chiefly the problem of attitude, but with adults it is more serious because of the strain caused to the spine as well as to the shoulder structures.

Anatomically the shoulder represents a part of the upper extremity, the position of which with reference to the rest of the body is maintained largely by muscles. The clavicle furnishes the only skeletal attachment, but as neither this nor its articulation with the sternum is designed for great strength, the importance of the muscular attachments is evident. The framework of the shoulder consists of two bones, the scapula and the clavicle, which are joined together at an acute angle, and these are placed saddle-fashion upon opposite sides of the upper part of the thorax. At the junction of these bones a socket is formed into which rests the head of the bone of the upper arm. Since the position of the shoulder with reference to the anterior part of the body is maintained largely by the clavicle, and since all motion must have the sterno-clavicular articulation for its centre, naturally the muscles are situated largely at the back and have their chief attachment to the scapula. If the muscles are removed the arm must drop downward, but if the clavicular attachment remains firm, since the upper part of the thorax is conical, in the downward movement the shoulder must fall forward as well.

As this tendency to sink downward and forward, from the mere force of gravity, is constantly active, it is evident that a large part of the function of the shoulder muscles is to prevent this and to hold the shoulders erect.

Normally in this erect attitude the scapulæ should rest upon the ribs at the back, and the centre of the shoulder-joint should be back of the centre line of the body, the position being one in which there is no evident strain to any part.

If now for any reason the muscles of the shoulder become weakened, the natural result is that the shoulder cannot be properly supported, and tends to sag downward; but as the downward position alone is not possible because of the comparatively fixed angle between the scapula and the clavicle and because of the conical thorax, the forward movement as well must occur. With such movement or under such conditions the shoulders are thrown forward so that the posterior muscles, upon which the correct poise of the shoulders largely depends, work at a greater disadvantage, and are subjected to unnatural strain, which if continued, must result in the weakening of these muscles with consequently an increase of the shoulder deformity.

Posture or any condition which results in the forward inclination of the body naturally increases the tendency of the shoulders to drag forward, and consequently increases the strain upon the pos-

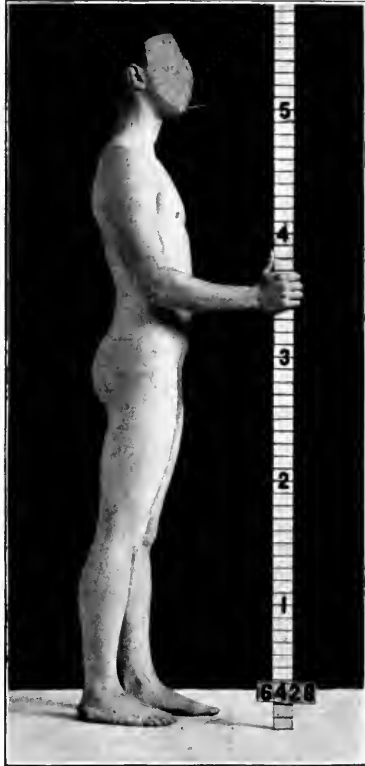


FIG. 267. A normal male figure showing the physiological curves of the spine, in a position in which there is no undue strain upon any groups of muscles.

terior muscles. Anything that allows the shoulders to sag forward must inevitably, since the shoulder and arm represent a considerable portion of the weight of the body, result in unnatural strain of the



FIG. 268.



FIG. 269.

FIGS. 268 and 269. These two figures show the disturbance in the poise of the body and the alterations in the spinal curves due to a forward position of the shoulder.

spinal muscles, which if continued results in these muscles becoming weaker, allowing the body to droop and to assume attitudes which are departures from the normal balance or poise. This in time must favor greater drag upon the shoulders, so that once the



condition is started, a vicious circle exists which can only be broken by correcting both the spinal and the shoulder positions at once.

In the movement of the shoulder forward, owing to the fact that the angle between the clavicle and the sternum is practically fixed, together with the conical shape of the upper thorax, the entire shoulder rotates forward and downward, so that the top of the acromion process, instead of facing upward and backward, faces more nearly upward. Not only this, but because in the movement the whole scapula moves to the outside, the upper portion moving faster than the lower, the long axis of the bone must incline farther to the outside at the top, with the result that the top of the acromion process faces outward as well as upward. With this movement the upper part of the scapula no longer rests upon the ribs, but is entirely free from them; and, as in this position the muscles tend to drag the upper part of the bone still farther downward, it is evident that if the condition occurs before these bones are fully ossified, their normal shape may be changed. In this position the scapula as a whole bears less evenly upon the ribs than it should, so that the entire bone may be misshapen; but as the upper part is the least supported it is naturally affected the most, and ordinarily this upper portion is the only part that shows noticeable peculiarity.

**Flexed Scapula.** Normally the scapula is slightly and evenly



FIG. 270. Note the flat chest, prominent inferior scapular angle and forward position of the shoulder. The head seems to be thrust forward and the lumbar curve is flattened, whereas the cervico-dorsal curve is exaggerated.

curved, following the conformation of, and resting evenly upon the posterior wall of the thorax, so that there is nothing in its formation that could interfere with the free movement of the shoulder up and

down or forward and back upon the ribs. If however the bone becomes bent, especially in the upper part where bending most often occurs, the free movement of the shoulder is interfered with and the end of the bone which inclines forward presses into rather than glides over the ribs. Not only is this so, but the flexion of the bone holds the main part or body of the scapula farther away from the ribs than is normal, and this results in the appearance of very large and overdeveloped shoulders when viewed from the back if the shoulders are held erect. In this position the depression be-



FIG. 271. The same case shown in Figure 270. Note the angel-winged scapula.

tween the shoulders is very marked. When viewed from the side the shoulder joint is seen to be much farther back than it should be, or at first glance the appearance may suggest the forward protrusion of the head. Because of the relative shortening of the clavicle which must exist when the scapula is thus held posterior to the

normal plane, the erect position results in so much strain that it can be maintained only for a short time, and as the muscles relax and the shoulders droop and rotate forward, the fact that the faulty position is in the shoulders and not in the head or spine, and also that the seemingly large size of the shoulders is apparent and not real, becomes evident.

The time when this bending of the scapula takes place must naturally be before the complete ossification of the bones. During



FIG. 272. Note the variation in the shape of these two scapulæ.

childhood in the periods of rapid growth the bones are soft and the muscles which should hold them in place are least able to do so. If under these circumstances any unnatural strain is put upon the muscles the development of the deformity is a natural result.

In the anatomical study of the scapula, great variation in the size and shape is at once apparent, as is suggested in Figure 272. There is marked difference in both the length and the width of the body of the bone, with a varying proportion between these two dimensions. The upper portion (above the spine) may be short or long relatively, while the position of the upper angle as well as its shape

is very inconstant. The shape and position of this angle, whether sharp or rounded, or whether near the inner border of the bone or over the middle of the body of the bone, is obviously of much importance as to the result which would follow the forward flexion of this part of the bone. The sharper the angle and the nearer this comes to the median line of the body naturally the greater the irritation that would result from the movement of this bone upon the ribs. In any case the bone may be flexed, but naturally peculiarities of formation may cause marked variation in the symptoms present in the given case.

**Congenital Elevation of the Shoulder.** In considering the causes for this forward position of the shoulders embryological conditions are of importance, as they have been shown to be of importance in relation to lateral curvature. In the early stages of development in the embryo the shoulders are considerably higher than they become later, so that the upper part of the scapulæ is opposite the lower cervical spine, fully two or three vertebræ higher than the position at full development. The descent from this position is a gradual one, so that at the time of birth it is practically that which remains during life. The significance of this feature in the subject under consideration is that at times the normal descent of the shoulders does not take place, and that if this is the case with the inelastic skeletal attachment of the shoulder, when it does not descend, it must be drawn forward as well as held elevated. In this irregularity in the descent of the shoulders the condition is analogous to the occasional imperfect descent of and the consequent irregular attachment of the ilia to the spine which, as has been shown by Dr. Boehm, has so much to do with the causation of the deformities of the lower spine and trunk.

In this failure of the shoulders to descend, the peculiarity may exist upon one side only, and the condition designated as the "congenital elevation of the shoulder," Sprengel's deformity, results, or it may exist upon both sides. If the latter be the case, the peculiarity is more apt to be overlooked and the child is simply supposed to be peculiarly formed or to have an unusually short neck.

That these embryological features are important in producing round shoulder, and that when present, the shoulders being elevated, the scapulæ, lacking the support of the ribs, tend to become misshapen, there is no question; but the most common cause is that which is represented simply by the weakness of the scapular muscles. The effect upon the scapulæ is the same during childhood whether the failure to descend prevents the bones from resting upon the ribs or whether in the simple sag forward from weakness the bones are no longer supported. In either case the upper part of the scapula, which is least supported, will be affected most.

Of the conditions which cause or favor the weakening of the shoulder muscles traumatism or joint lesions should be mentioned, as should also the paralyses, of which the infantile is the most often seen; but by far the most common causes are occupations or conditions which produce strain and lead to muscle fatigue with ultimate muscle wasting. Certain trades are noted for such deformities. The carpenter's back is a type, the back being rounded with the shoulders inclined forward, and represents the attitude which naturally results from the fatigue of the muscles consequent upon the common stooping posture. In many other trades similar conditions exist. With children the most important element is the adjustment of the clothing, and this is so important that it cannot be too strongly emphasized. During the first three or four years of age, while the clothing is loose and of little weight, the average child is erect, the back is flat, and the shoulders are well poised. As the child grows and the clothing of the infant is given up for that of the child, a marked change very commonly takes place, so that the average child between the age of six and fourteen is more or less round-shouldered, the posterior edge of the scapulæ showing as the so-called "angel wing." During this period the children are constantly being reminded by the parents to stand or sit erect. The cause for this change is to be found largely in the improper adjustment of the clothing, this occurring at the time when, because of the condition of rapid growth, the organism is least able to withstand strain. The child's costume is practically all attached to the under-

waist, this being supported by straps over the shoulders, and to this not only is the clothing attached, but the stocking-straps as well. The weight carried upon each of these shoulder-straps as the average child is dressed is from three to five pounds, and while this represents an amount that could easily be carried for a short time, if it is continued for the entire day it naturally represents much fatigue of the supporting muscles. A strain of this kind continued naturally weakens the muscles so that they are less able to perform their natural function, and the erect position of the shoulders becomes more and more difficult. The result of this continued strain with the increasing weakness of the muscles is naturally to favor the increase of the deformity. The shoulders droop more, the posterior edge of the scapula becomes more prominent, and the upper part of the scapula thus unsupported bends forward.

Recognizing these two features, the weakness of the posterior scapular muscles and the forward bending of the scapula, it is easy to understand many of the symptoms of which these patients complain. The mere attitude, which at times is the reason for which treatment is sought, has been sufficiently explained and may be present entirely without subjective symptoms. Those who seek treatment because of symptoms other than faulty attitude are usually adults or adolescents, with whom the scapular malformation, if present, occurred of course during childhood when the bones were soft, and the special symptoms are due either to strain of the posterior scapular muscles, to the mechanical irritation produced by the upper angle of the scapula pressing into and rubbing over the ribs, or to the strain which this imperfect position of the upper part of the trunk exerts upon other parts of the body, chiefly the lower spine and the sacro-iliac joints. In the first of these conditions, the pain may be referred to any part of the scapular muscles or their attachments, and may be so indefinite at first as to receive little attention. Upon analysis, however, it will be found that the distribution of the pain is consistent with anatomical features, almost always being referred to some muscle or portion of muscle which is being strained. The trapezius is naturally the one most commonly

involved, and the frequent pain at the occiput or referred to the back of the neck is commonly due to the strain of the upper part of this muscle, which is used more than the lower portion in the unconscious attempt to hold the scapula up and away from the ribs.

The symptoms which are due to the direct pressure of the scapula upon the ribs consist chiefly of pain referred quite definitely to the point of the irritation, and are produced only when the bones are in such position that the pressure can take place. The pain, which may be very acute when the shoulders are thrown back, will be entirely relieved when the shoulders are allowed to drop forward, because in this position the bones no longer impinge. For this reason, occupation or exercise which is performed with the shoulders erect may cause much suffering or be impossible, but the same occupation or exercise performed with the shoulders forward, or even involving greater effort, may be performed with ease. Lawn tennis, for instance, if an overhand stroke is used, or overhand throwing, will be difficult, while the motions of golf or squash tennis or underhand throwing may be easily performed.

The slipping of the angle of the bone over the ribs is usually easy of demonstration and if the hands are placed upon the shoulders at the back and the shoulders are then moved up and down or forward and back, the slipping or crepitation, as it is frequently termed, is easily felt. It is this feature that has frequently been supposed to be due to a subcapsular bursitis, but as there are no bursæ of importance under this portion of the scapulæ this feature may be at once dismissed. The only instance in the cases which the writers have seen in which a bursa was at all responsible for the symptoms was one in which the bursa which is situated under the tendon of the trapezius where it crosses over the base of the spine of the scapula was inflamed. In this case the bend of the scapula forward was so marked and the scapulæ necessarily thrown so far back that the muscle was forced to pull over much more of an angle than is normal, and this fact, together with a sudden increase of work in which this muscle was used, resulted in an acute inflammation of the bursa. In this case the bursa was so superficial that the differentiation

between this and the crepitation due to the rub of the bones upon one another was not difficult.

Apart from these local symptoms any such forward position of the shoulders must necessarily change the natural poise of the body and if maintained for any length of time will result in strain to some other part. The lower spine with the sacro-iliac joints and the feet are the parts of the body most often affected. This, together with the fact that the stoop shoulder itself may primarily be part of a general weakened musculature, explains the common occurrence of foot and lower back symptoms in cases in which the shoulder position may be the most conspicuous feature. It is evident that where such symptoms of resulting strain exist, their permanent relief is impossible unless the proper poise of the upper part of the body is obtained, and if the proper poise is not possible because of deformity of the scapulæ then this should be corrected, even though the symptoms may not be directed to this region.

**Shoulder Joint.** In that which has been stated thus far the shoulder as a whole has been considered, the consideration of the shoulder joint proper being purposely reserved until later, since many of the shoulder joint conditions are definitely due to malpositions of the shoulder girdle, and are to be corrected only by first correcting this. In the first place the anatomy of the joint must be considered.

The shoulder joint is formed of the glenoid cavity, against which the head of the humerus rests, and this is rendered more stable under ordinary conditions by the coracoid process in front and the acromion process above and a little at the back of the joint. The bones are held together by ligaments, which under ordinary conditions give the greatest stability that is in keeping with freedom of motion.

Being a ball and socket joint, motion in all directions is allowed in varying degrees, but it is to be borne in mind that much of the motion commonly supposed to be made in the shoulder joint proper is either made in or allowed by adjacent joints and structures. For instance, it is entirely possible to shrug or raise the shoulder, or to



carry the shoulder well forward into the droop-shoulder position, without the arm being moved from the body, or, in other words, without the shoulder joint proper being moved at all, or at most but very slightly. In this also as in most of the movements of the shoulder at the same time there is motion in both the acromio-clavicular and the eterno-clavicular articulations, and disease of either of these joints will naturally lessen the amount of motion possible for the shoulder.

The amount of motion possible in the shoulder joint depends to a considerable degree upon the position of the entire shoulder, a fact which is of much importance in the stability of the joint. In the forward position of the shoulder, the round or stoop shoulder attitude, there is from fifty to sixty degrees more motion in rotation of the humerus in the glenoid cavity than



FIG. 274. Note the short coracoid.



FIG. 273. Note the short coracoid with the inclination upward.

is possible when the shoulder is held erect. In other words, the erect position is the position of greatest stability, while the forward position is the position of greatest instability, — facts which should be considered, especially in treating shoulder dislocations. This variation in the mobility is due partly to the ligaments and partly to the changed relations

between the head of the humerus and the coracoid and acromion processes. Neither of these processes is constant in its size or shape



FIG. 275. Note the long coracoid with the downward inclination.

or in the inclination of the axes, so that there must be considerable variation in different individuals in the amount of or character of motion present in positions which are relatively the same. It is evident that if the length or angle of the coracoid process is not constant, the degree of contact between its tip and the lesser tuberosity of the humerus must vary. Not only is this true, but the same thing is true of the acromion process, and both of these factors are of much importance in the matter of function and stability of the shoulder joint.

The coracoid process may be short (Figure 273) or long (Figure 275). It may project upward (Figures 273 and 274) as well as forward, or it may project downward (Figures 275 and 276). The forward inclination also varies (Figures 273, 275, and 277). With the acromion process the variations are also striking. The length and breadth of the process as well as its axes in relation to the axes of the shoulder joint are not constant. The process normally faces upward and backward, its axis drawn through the length of the bone being up-



FIGS. 276 and 278. Showing the downward inclination of the coracoid.

ward and forward about 35 degrees from the horizontal. Its normal position when the body is erect is such that it is almost entirely above the line of the joint, dropping below only slightly at the back. The variations in this axis are quite marked, as is shown in Figures 273, 274, and 278. Because of this variation in the position of the acromion process, combined as it often is with an increase in its length (Figures 274, 276, and 278), the character and amount of motion in the shoulder joint must naturally vary.

The effect which these peculiarities in the shape of the bony processes must have upon the movements of the shoulder joint is a matter of much importance. The greatest amount of motion at the shoulder will be possible in those cases in which there is a short acromion set in the common position above and a little behind the joint, with a short coracoid process, and the least possible



FIG. 277.



FIG. 278.

downward inclination. If, however, the coracoid process is long, and especially if it inclines markedly downward, the forward motion of the arm will naturally be limited, because under such conditions the lesser tuberosity of the humerus impinges forcibly against the tip of the process

and much earlier in the movement than if the process were short and the inclination upward. If the acromion process is longer than normal it will naturally limit raising of the arm over the head, while if the process is placed more at the back of the joint than is normal, the movement of the arm backward will also be limited. This deepening of the cavity of the shoulder joint, which is the practical result of the elongation of these processes, naturally implies an increase in the stability of the joint, and while under certain conditions this is the actual result, under other conditions stability is materially lessened for the following reasons. If the acromion process is longer than normal, it is evident that if the arm is raised straight from the side and carried over the head, or if, especially when the acromion is placed more at the back of the joint than usual, the arm is carried backward as well as raised, the greater tuberosity of the humerus strikes against the acromion process, and the result of this is that if this motion is continued the acromion process represents the fulcrum of a lever and the head of the bone tends to be forced out of the glenoid cavity. If the force applied under such conditions is sufficient, a true dislocation takes place. If in connection with this application of force the stability of the joint is less than normal, which may result from previous dislocation or inflammation, in consequence of which the capsule is relaxed, dislocation will take place more easily. Under such conditions the displacement would be either forward or downward.

While such results are possible when the acromion is abnormally long or peculiarly shaped, a similar condition may also result if the peculiarity of shape is in the coracoid process. If this is long, or especially if it is inclined downward, when the arm is carried forward the lesser tuberosity of the humerus is brought in contact with the tip of the process and the head of the humerus is lifted out of the glenoid cavity when sufficient force is applied. In this case the coracoid process acts as the fulcrum instead of the acromion. In the forward position, because of the fact that the anterior ligaments are short and firm, when the head of the bone is lifted from the glenoid cavity it must either slip off the upper side of the coracoid process,

in which case it falls back into the cavity, being forced in by the acromion process above, or it slips off the coracoid process below, in which case a subcoracoid or subglenoid dislocation takes place. If the anterior part of the capsule has not been torn by the violence,



FIG. 279. Shoulders held erect. The dotted line shows the inclination of the scapular spine.

the subcoracoid position, the head resting directly under the coracoid process, will be the invariable rule, since the short anterior ligament must restrict the range of motion, making more remote positions impossible.

If the shoulder is held erect with the scapula flat upon the ribs

(Figure 279). the humerus is not in contact with either the acromion or coracoid processes, unless the arm is rotated inward or drawn toward the centre of the body, but the separation is only very slight and the position of the coracoid process is even

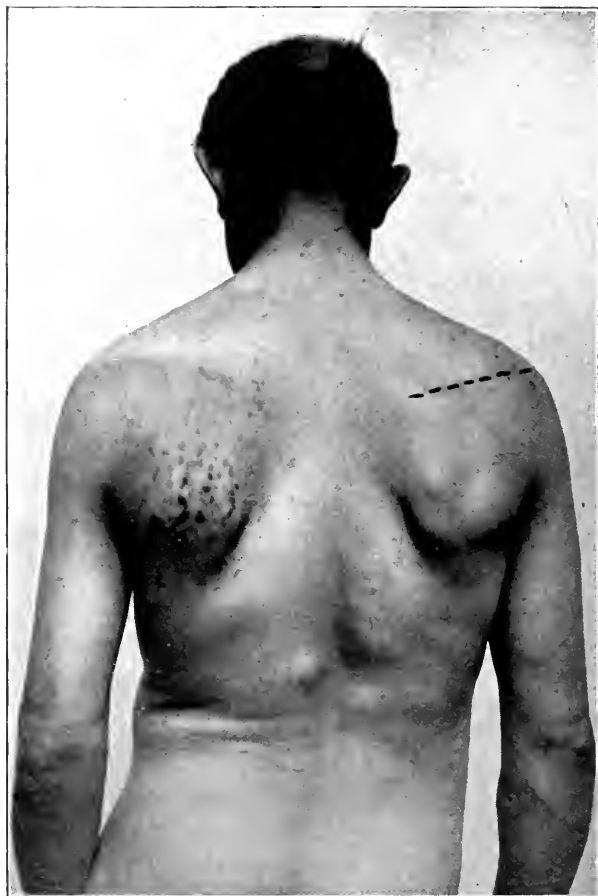


FIG. 280. The shoulders drooping. The dotted line when compared with that in Fig. 279 shows a change in the inclination of the scapular spine.

under these conditions distinctly below the top of the humerus. (Figure 275.) If the shoulder is allowed to droop, the whole girdle is moved forward, outward, and downward, so that the scapula faces upward and outward much more than in the

erect posture, and not only is this true, but the perpendicular axis of the scapula is also changed and inclines more to the outside. (Figures 268 and 269.) The axis of the bone with reference to the antero-posterior position is well shown in Figures 279 and 280. In this rotation the coracoid and acromion processes naturally are brought forward and downward, and the point of contact of the coracoid process with the humerus is made necessarily lower and must be more constant, especially since in this forward position the capsule of the shoulder joint is relaxed, and the natural drag of the arm downward and forward must bring the bones more firmly together.

**Recurrent Dislocation of Shoulder.** In all that has been stated thus far no other conditions have been considered than those which represented either congenital or acquired peculiarities of anatomical form, and without reference to disease. It is evident that in such conditions as have been described, if either or both of the processes are long or peculiarly placed the constant strain upon the joint capsule which such mechanical features would cause must weaken the capsule of the joint so that further strain would increase the possibility of ultimate displacement. If these anatomical peculiarities are very marked it is easy to understand the ease with which dislocation takes place, even though no great violence occur. When such conditions exist and a violence is received causing a dislocation, the tear of the ligaments which such a violence usually produces will still further weaken the capsule, and dislocations may subsequently take place more easily. In the history of the cases of recurrent dislocation of the shoulder joint not infrequently the difficulty dates from a traumatic dislocation, but in most of these instances it is evident that the subsequent displacements are largely due to some of these anatomical peculiarities above described. It is also probably true that in many of the cases the first displacement would not have taken place had not these anatomical peculiarities existed, and it is certain that the greatest stability of the shoulder joint cannot be obtained until these peculiarities are recognized.

It is not to be inferred from this that the writers consider all re-

current dislocations of the shoulder due only to these two factors, i. e., the anatomical peculiarities of the coracoid and acromion processes and relaxation of the capsule, because other factors are at times present, but in no case which has come under our observation has the existence of these anatomical peculiarities and the relaxed capsule not been present. The final cure has depended upon their recognition, even when other factors played a part. With a more general recognition of these two factors operations upon the shoulder for habitual dislocation will undoubtedly be less often required than was formerly thought necessary, and the results of the operations will be more constantly satisfactory.

The conditions most often found to be contributing factors to the displacement have been adhesions in the subacromial or subcoracoid bursa, or rupture of the tendon of the supra-spinatus muscle, a condition described by Dr. E. A. Codman. In one case a piece of the glenoid cavity had been broken off, the partially detached fragment acting as a fulcrum to pry the head out of position. Even in this last case however a stable joint was not obtained until the use of the shoulder was controlled so that the abnormal striking of the head of the humerus against the coracoid or acromion processes was impossible.

**Subacromial (Subdeltoid) or Subcoracoid (Coracobrachialis) Bursa.** To prevent undue irritation from the impingement of the bones at these processes during use, bursæ exist, and are of much importance in the understanding of the clinical phenomena met with at the shoulder joint. The subacromial, or subdeltoid, bursa is situated under the acromion process outside of the capsule of the shoulder joint and extends over the greater tuberosity of the humerus and out under the upper part of the deltoid muscle. In raising the arm from the body at the side the surfaces of this bursa glide over each other, and if for any reason the bursa becomes inflamed this motion will be attended with pain, and if such inflammation exist or adhesions have formed motion will be limited. This bursa, which has been best described by Dr. E. A. Codman ("Boston Med. & Surg. Journal," Oct. 22, 1908, et seq.), because



of its exposed position is especially liable to injury and is undoubtedly the cause of many of the cases of so-called periarthritides.

At the coracoid process a bursa, the subcoracoid or coracobrachialis, also exists. This is situated between the tip of the coracoid process and the outer surface of the capsule of the shoulder joint as it extends to and over the lesser tuberosity of the humerus. While this bursa is less exposed to external violence, it is much more liable to injury, because much of the use of the arm in the common attitudes which are assumed subjects this bursa to irritation by pressure of the lesser tuberosity of the humerus against the coracoid process.

If these bursæ become inflamed or injured, the clinical picture is characteristic and of much importance. When the subdeltoid bursa is involved the pain is usually referred directly to the location of the bursa or over the distribution of the deltoid muscle, frequently to the attachment of this muscle to the humerus. The limitation of motion under such conditions is, as would be expected, abduction or the raising of the arm from the body at the side with rotation being most marked. Since both the supra-spinatus and the deltoid muscles are concerned in making this motion and since the bursa lies between these, outside the tendon of the supra-spinatus, which is a part of the upper portion of the capsule of the shoulder joint, and under the acromion process as well as the deltoid muscle, this limitation is easy to understand. Flexion or extension of the arm without raising it from the side is as a rule quite free, and rotation, unless adhesions are present, if performed without raising the arm, may be but little limited. Rotation with abduction of the arm will be limited, since in this motion the bursal membranes are compressed between the acromion and the greater tuberosity of the humerus, as well as strained from the pull of the supra-spinatus and deltoid muscles. If adhesions have formed the motion will be constantly limited in the directions indicated, and the extent of the limitation will depend upon the extent of adhesion formation. If the cavity of the bursa is wholly obliterated all rotation and nearly all abduction at the shoulder joint will be impossible. Even when the

bursal sac has been quite obliterated flexion and extension of the arm in an antero-posterior plane with the arms at the side may be quite free.

With the subcoracoid bursa as the result of a posture, such as occurs when the shoulder is habitually carried forward (the round or stoop shoulder attitude (Figures 268, 269, 270), the lesser tuberosity of the humerus rests against the tip of the coracoid process, and in many occupations the arm is used so that these two bones are in contact more constantly or with more force than is normal, under which circumstances the bursa becomes inflamed exactly in the same manner that the præ-patellar or the olecranon bursa becomes inflamed in occupations or postures in which these synovial sacs are injured or repeatedly strained. Because of the position of this bursa and its almost constant use in motions of the shoulder it is undoubtedly more often inflamed or affected by violence than any of the other bursæ about the shoulder joint.

If such an inflammation occurs, there will be pain and sensitiveness, with limitation of motion during the acute stage, with either an entire disappearance of the symptoms as the inflammation subsides, or if adhesions have formed as a part of the inflammation there may be an entire disappearance of pain and tenderness, but limitation of motion will persist. This limitation of motion at the shoulder joint, when caused by adhesions, is such as one would expect if the anterior part of the capsule of the joint were attached to the coracoid process. Such an adherence of these structures would not interfere materially with flexion or extension of the arm as long as motion is made in an antero-posterior plane, or with raising the arm from the side, provided the motion is made in a purely lateral plane, because in all these motions the subcoracoid bursa is comparatively little used. If, however, rotation is attempted, either with the arm at the side or when the arm is raised, limitation is at once apparent, because in rotation the lesser tuberosity of the humerus must either glide over (in inward rotation) or move away from (in outward rotation) the coracoid process, and it is apparently to allow this motion without friction that the

bursa is provided. If the surfaces of the bursa are adherent or inflamed the limitation in this motion would naturally be expected. It is this limitation that makes difficult the putting on of a coat or similar garments, the dressing of the hair, the fastening of the bands of shirts, etc., all of which involve movement of these bones in rotation one upon the other. Other motions, however, may be freely made, because in these the lesser tuberosity of the humerus and the coracoid process do not materially change their relations.

If an inflammation of this subcoracoid bursa has once taken place and if adhesions have formed, the character of the shoulder joint motion must necessarily be changed. If the adhesions are few or the membranes are not held tightly together, the change may be slight and of comparatively little importance. If, however, the adhesions are firm and, as often is the case, the bursal cavity is entirely obliterated as the result of a general adhesion of the two surfaces, this change then becomes of much importance, since it means that the tip of the coracoid process becomes the centre about which all of the shoulder joint motions must be made. In flexion or extension the head of the humerus can no longer glide under or away from the coracoid as is normal, but the head of the humerus must slide in and out of the glenoid cavity, the amount of this motion being limited by the capsule and the bony structures. Rotation will not only be limited more than other motions, but if the adhesions are firm outward rotation of the arm will be impossible, since in this the head of the bone is simply pressed more firmly against the bottom of the glenoid cavity. In inward rotation what little motion may be present is the result of lifting the head of the bone out of the glenoid cavity, the coracoid process acting as the fulcrum over which the bone is drawn. In both of these motions it is to be remembered that even though the limitation just described may be marked, the motion at the acromio-clavicular articulation and the movement of the scapula over the ribs may compensate for this limitation to a moderate degree.

If now such a condition exists and for any reason the capsule of

the shoulder is relaxed it is at once apparent that the stability of the joint must be still further lessened. Under such conditions if the arm is raised upward and at the same time rotated, dislocation of the head of the humerus is an almost natural result. In such movement the bone is simply lifted out of the socket, and if at the same time there is violent muscular effort of any of the muscles, especially if the biceps acting through the long head are thrown into spasm, dislocation is to be expected. Since the lesser tuberosity of the humerus remains in contact with the tip of the coracoid process, the displacement will be with the humeral head under the coracoid process, the subcoracoid or anterior position.

Of the subjective symptoms commonly present in these cases, pain is one of the most common and this may be referred definitely to the region of the bursa, or if the inflammation is more general or extensive the distribution of the pain will also be more general. If the coracoid bursa is the one involved, pain is usually located just outside the tip of the coracoid process. At times pain is referred to the deltoid region or down the arm, the region of the attachment of the deltoid to the humerus being a common place, or along the course of the ulnar nerve. Occasionally the whole arm and hand are painful, and associated with this there may be disturbances of circulation, the whole condition appearing like a true neuritis. If there is active inflammation of either the subcoracoid or the subdeltoid bursa, pain will be present as long as the inflammation continues, but it will be aggravated by use or those positions in which strain is brought upon the inflamed parts. If, however, no true inflammation exists, then the pain, which may be very severe at times, will be relieved or aggravated by change of position. Under such circumstances the pain is often most severe at night, usually coming on in paroxysms and being relieved by change of position. The reason for this is readily apparent when the mechanical and anatomical conditions which have previously been described are recognized. Before sleep the arm is placed in some position of ease, usually with the forearm across the body, with the patient upon the back. In this position the elbow and upper arm are not supported,

but depend upon the position of the forearm and the contraction of the muscles for the preservation of this posture. In sleep the muscles relax, the arm and elbow drag down to the side, the forearm being drawn off its position upon the front of the body until the elbow and arm rest upon the bed. In this movement the arm is rotated outward, and this must strain the sensitive area. If this strain continues the patient finally awakens, and it is not until the position is changed that the pain is relieved. Support of the elbow so that this rotation cannot take place usually prevents pain due to this cause.

**Brachial Neuralgia. Neuritis.** In many cases pain is referred to the arm and hand and frequently with great definiteness to the distribution of a special nerve, most often the ulnar. This condition may be seen in connection with inflammation of the bursæ about the shoulder, or there may be no evidence of such bursal involvement. The pain under these conditions is not associated with inflammation of the nerve sheaths showing by pressure along the course of the nerve, nor are there motor or sensory disturbances other than pain. Drugs or external applications are as a rule of little help, and the fact that the chief relief usually comes from the change of attitude or posture which the patient has usually learned by instinct, suggests a mechanical element as a cause for the trouble. Resting the arm upon pillows at night with the elbow raised from the side, the sitting posture for sleep, the forward position with the arm resting upon a table, all attitudes often assumed by patients with this type of pain, suggest something other than primary nerve or nerve sheath lesions as a cause of the trouble.

In this type of case the forward position of the shoulder as the habitual attitude is constant and the pain is increased in proportion to the increase of this droop. In slender persons the pain is almost always referred to the distribution of the ulnar nerve, while in persons inclined to be stout the pain is more general, as if all of the nerves of the arm were involved. Inward rotation of the arm usually causes an increase of pain, while raising the arm from the side and the elevation of the shoulder usually gives relief.

Anatomically, with the drooping of the shoulders the head of the humerus drops forward and downward, ultimately resting against the ribs. In this position the ulnar nerve lies almost directly under the head of the bone, this being the most posterior of the branches of the plexus, and it is pressed upon as it crosses the second rib. If subcutaneous fat tissue is present in considerable amount the pressure exerted is more apt to be upon all the axillary structures, pressure upon an individual nerve being less easy of accomplishment, and more general pain is the result.

Recognizing this, the relief obtained by the various positions instinctively assumed by the patients is easily understood. Not only does this explain some of the obstinate cases of neuritis of the arm but also some of the cases of writer's cramp. In these latter cases so far as it has been possible for the writers to observe them, the pain has always come on after writing at a desk or sitting with the body inclined forward. When such an attitude is first taken there usually is no pain, but if it is maintained for any length of time pain develops and increases the longer it is maintained. This is of course aggravated by the fatigue of the muscles, which allows the shoulder to sag forward. At first the position is with the body reasonably erect, but as the posterior muscles tire forward inclination of the body becomes more and more marked until the final position is with the body much flexed and supported almost entirely by the table, the arms under these conditions being used with much difficulty. Under these conditions, the inclination of the trunk forward, the shoulder muscles are strained so that the shoulder itself droops more and more forward, and as the arm carries some of the weight of the upper part of the trunk, the head of the humerus is crowded more and more firmly against the ribs, and the result of this is that if the nerves of the brachial plexus lie under this they are compressed more and more until not only does the pain become intense, but temporary paralysis of the arm ensues.

## TREATMENT

**Round or Stoop Shoulders.** The treatment of round shoulders consists of such measures as make possible the correction of the malposition, with the removal, in so far as is possible, of such elements as would tend to favor a return of the deformity.

In young children, beginning with the common well-poised infant, preventive treatment only is indicated, and this consists almost wholly in the proper adjustment of the clothing so that the support is put upon the base of the neck instead of upon the tip of the shoulder as is commonly done. If this rule is observed, the shoulder position of the child will not be unlike the erect shoulder of the infant, unless sickness or some other cause produces

abnormal weakness of the muscles with resulting imperfect support.

With the young child in whom the shoulders have already become drooped, the readjustment of the clothing is the first requisite, so that the weight is supported in such a way that undue strain does



FIG. 281. Showing a common underwaist with the straps bearing upon the outer part or moveable part of the shoulders.

not result. For this the underwaist, which is for the present probably the best mode of attaching the clothing, should be carefully fitted so that instead of having the shoulder-straps placed in such a way that all of the drag is received upon the tip of the shoulder, together

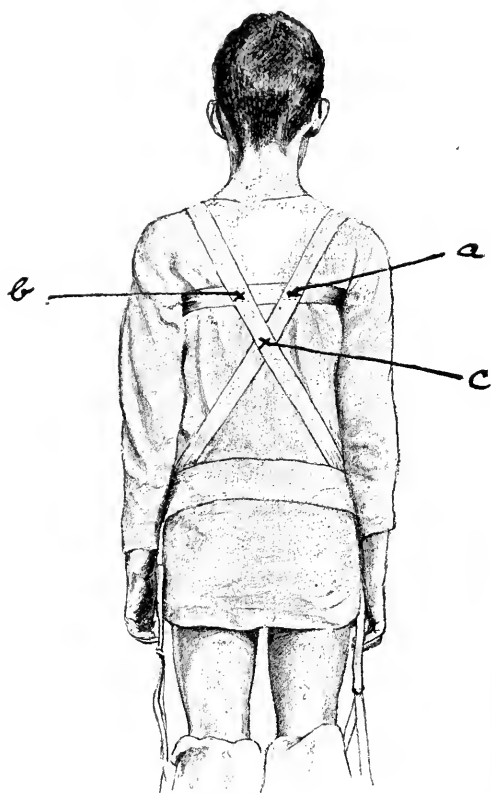


FIG. 282. Note the position of the cross shoulder-straps and the point of bearing on the shoulder. This shoulder-strap is made of webbing and is attached to a yoke at the hips.

with the forward pull of the cross-strap as the waists are commonly made, they should be cut high in the neck at the back so that the drag comes upon the upper part of the shoulder close to the neck and the outer part of the shoulders is left entirely free. To accomplish this the waist should open in the front, and this part should be cut so as to be quite full and make no compression over the chest. The neck in front can be cut low if this is desired, and the cross-straps upon which the chief drag comes should cross over the shoulders

high up near the neck and then extend down to the hip on the same side, crossing the upper thorax in front well to the outside, so that in the pull the shoulder is forced backward and the minimum amount of pressure upon the thorax is exerted. In the back the waist should be cut high in the neck and should be fitted so as to be quite flat, not loose as the front should be. The cross-straps should



pass over the shoulder from the front near the base of the neck and then over to the other side, crossing the opposite strap like suspenders. These straps at the back join at the sides the straps after they have extended down the front, and at the point of their attachment at the side the buttons for the stocking-straps and the heavier clothing should be fastened.

In the young children this adjustment of the clothing with good care and ordinary exercise is usually enough to bring about the restoration of the proper poise of both shoulders and trunk.

If the condition is more marked or has existed for so long that the posterior muscles have been weakened by the continued strain, not only should the support of the clothing be properly arranged, but a brace of some form should be used to hold the body erect and the shoulders back. Such a brace is naturally for temporary use and should be worn only until the position has been satisfactorily corrected and until proper measures have resulted in bringing the muscles up to their proper tone. If the

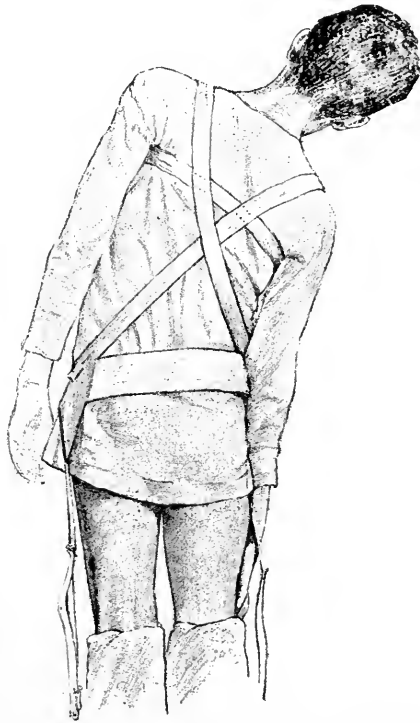


FIG. 283. Note the effect of side bending upon the shoulder-straps.

scapulæ have not become flexed, a brace should not be required for more than three or four months, and during that time special exercises should be used in order to strengthen the muscles which are involved in holding the body erect, so that when the brace is discarded there will be no tendency to relapse.

In case braces become necessary, anything that holds the body erect and the shoulders back will be satisfactory, provided the



FIG. 284.

thoracic movements are not interfered with. Ability to breathe freely and deeply is essential to the best health, so that in the apparatus as well as the clothing nothing should be used that interferes with this. For this reason jackets of any kind, since they encircle the body and necessarily restrict the movement of the chest, should be used as little as possible. Of the special braces a simple and efficient form consists of two uprights of flexible steel which extend up the back along the sides of the spinous processes, and are held in place by a band which partly encircles the body at the hips, and a crossbar at the shoulders. To the cross-

bar shoulder-straps are attached, and with these and a strap about the pelvis or abdomen it is held in place, without interfering with the thoracic movements.

**Flexed Scapulæ.** In case the scapulæ have become flexed, so that because of this the correct position of the shoulders cannot be obtained by simple means, the treatment naturally consists in the correction of this mechanical feature. If this peculiarity in the shape of the bones is recognized before they are completely ossified, it should be the endeavor to correct it without operation, and this can usually be done by means of a brace which holds the scapula well back upon the ribs, and with the continued pressure the scapulæ are gradually flattened. For this purpose the brace pictured in Figure 287 and similar to the one described above, except for the body strap, is most practical, and will usually at suitable age accomplish the result. At times it is necessary to hold the shoulders more firmly, and the forcible correction of the position of the bones with the

maintenance of the position in a plaster of Paris jacket may be required, but this is not often the case, and because of the interference with the thoracic function the jacket should be removed as soon as possible. With patients of fifteen years or less correction without operation is usually possible and the time required for the use of apparatus will naturally depend upon the character of the bones. If the ossification is far advanced it will naturally take longer



FIG. 285. Front view of Figure 286. Note the continuance of the shoulder-straps down the front of the waist.

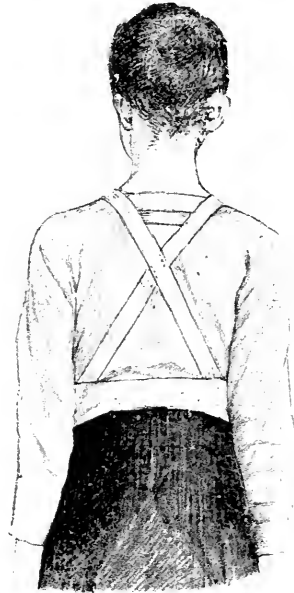


FIG. 286. Compare with Figure 282. Note the high crossing of the shoulder-straps and the bearing points nearer the root of the neck.

than if this is less advanced, but in any case if the correction is to be accomplished by the brace not more than four or five months should be required, while with the young children the time may be considerably shorter.

During the time that the brace is worn exercises should be regularly carried on with the idea of developing the posterior trunk and scapular muscles, which are particularly weak in such cases.

When treatment is sought after the bones have become ossified

there is nothing to do to really relieve the difficulty other than the removal of the upper portion of the scapula. Temporary relief can be obtained by strapping or in any way holding the shoulder forward so that the rubbing of the bones over the ribs is impossible, but this naturally is only palliative and should not be encouraged for long, as it inevitably results in increased strain upon the posterior muscles of the scapula and the spine. Braces holding the shoulders back are unsatisfactory, since the crowding of the scapulæ into the ribs is increased by this and the pain frequently aggravated.

For the removal of the upper portion of the bone the following operation is that which has been regularly employed by the writers since it was first found to be important. With men an incision three inches long is made parallel to and just above the spinous process of the scapula. With women, because of the importance of the avoidance of conspicuous scars and recognizing the character of the conventional costume, the incision is curved, starting near the lower part of the scapula and extending to the acromion process. In either case the skin is dissected until the attachment of the trapezius muscle to the spine of the scapula is uncovered. This is then incised, beginning in the tendinous portion at the inner edge of the spine of the scapula, until an opening about two inches long is made. Through this the supra-spinatus muscle is exposed and scraped back from the upper portion of the bone, until as much as is to be removed is denuded. The tendon of the levator anguli scapulæ is separated from its attachment with the periosteum elevator, but the tendon which has a common attachment with the tendon of the rhomboid minor is not divided. After this a straight cutting pair of bone forceps is inserted and enough of the upper part of the scapula removed to prevent the rub of the bone upon the ribs. The tendon of the trapezius is then sutured in place and the wound closed without drainage. A simple gauze dressing should be applied and held in place with swathe or bandage, not attempting to entirely immobilize the arms.

For three or four days the patient is kept in bed and is then allowed to sit up, use of the arms being allowed as the immediate

sensitiveness of the incision disappears. As a rule, at the end of the first week the patient is able to walk about and at the end of another week is able to use the arms with considerable freedom.

This naturally relieves the mechanical irritation and the pain which resulted from this ceases, but the condition is of course not wholly cured, since in the long forward position of the shoulders the posterior muscles have become weakened so that after the healing from the operation is complete, exercises or other procedures should be insisted upon which have for their purpose the strengthening of the weak structures and the restoration of the normal poise of the body, with the ultimate entire cure of the difficulty. Not only should the muscles which have to do with the scapulæ be developed, but those which support other parts of the body, which from weakness would lead to attitudes of strain for the shoulders, should be treated. If the

spine is bent forward this should be corrected in so far as possible. If the pelvic joints are weak, so that the common attitudes of fatigue, in which the whole body droops with the shoulder thrown forward, exist, these should be treated. If the position of the feet is such that the correct poise is not possible, this also



FIG. 287. The type of spring back-brace used in round shoulder.

should be overcome, and in fact everything should be done to make the normal erect position of the body possible without strain.

**Subdeltoid and Subcoracoid Bursa.** Once it is recognized that the stability of the shoulder joint becomes less as it is carried forward or droops, together with the fact that abnormalities of the coracoid and acromion processes in this forward position distinctly interfere with motions which in the upright position could be freely made, and furthermore that in this forward position the subcoracoid bursa may be compressed between the lesser tuberosity of the humerus and the coracoid, and the axillary contents, especially the nerves, may be crowded against the ribs, the first requisite in treatment consists in changing this forward position of the shoulder so that the body is erect.

In this position the relations between the coracoid and acromion processes and the humerus are such that there is no undue pressure one upon the other, the axillary contents are not compressed, the stability of the shoulder joint is increased, and displacements are difficult of occurrence.

In the irritation or inflammation of bursæ, especially the subcoracoid, if no adhesions are present the mere change of attitude may cause marked relief at once. At other times when inflammation is more severe relief is not as immediately noticeable, but if an erect position is maintained the compression of the bursa which must occur in a forward position is no longer present and the inflammation gradually subsides. If adhesions are present pain is sometimes increased in the attempt to hold the shoulder back, since in this position the adhesions are stretched. Under such conditions, or wherever adhesions are present, these should be overcome if we are to expect normal use of the arm. In case such a procedure is contemplated when there is much inflammation of the bursa as shown by acute pain or tenderness, it is well to keep the arm quiet for a few days until this has lessened before the manipulation is undertaken.

**Manipulation.** In the manipulation if restriction in motion is at all marked, an anæsthetic should be used, and as only a few mo-

ments are required, nitrous oxide is usually sufficient. The limitation of motion where the subcoracoid bursa is involved is chiefly in rotation, but in the manipulation rotation should not be attempted at first, as the adhesions are often so firm that a spiral fracture of the humerus may result, and as the writers have seen this occur once in the hands of a colleague it is not a fancied possibility. Whether the subacromial or subcoracoid bursa, either or both, the manipulation is similar. The arm should first be flexed and extended in the antero-posterior plane as much as possible and should then be raised from the side, one hand grasping the elbow, the other holding the shoulder so that the scapula does not move. After a right angle with the body has been reached the arm should be carried higher and should at the same time be rotated outward until when it is vertical it is outwardly rotated to the full, normal amount. In this combined rotation and abduction the bursal membranes must be separated with rupture of the adhesions, and the force is applied in such a way that there is no danger of injury to the bone. After this motion has been made, then both inward and outward rotation of the arm at the side should be tested, and while this will usually be possible to the full amount, if any adhesions remain they can be easily overcome.

After full motion has been obtained in either of these bursal conditions the shoulder should be held fully extended so that the scapula rests upon the ribs at the back, and this can be best accomplished by adhesive plaster strapping. If for any reason this is not available, then bandages or sandbags should be used for the same purpose, recognizing that in this position with the shoulder thrown back the surfaces of the bursa are separated and consequently the liability of fresh adhesions forming is reduced to the minimum. Quiet for a day or two should be encouraged, and during this period local heat in any form will be of help, after which the patient should be allowed to go about, encouraged in the use of the arm, but always with the shoulder erect. Passive and active motion should be used until the normal amount is obtained. Usually after the full motion is obtained no further trouble results. Occasionally, however, the

peculiarity in the shape of the coracoid process is such that ordinary use of the arm is attended by irritation at that point so that it becomes a matter of serious consequence. Under such circumstances, in case the scapula can be held in its right position so that the trouble at the tip of the process is due entirely to the peculiarity in its shape, then if other things have failed an operation should be performed and enough of the end of the coracoid process be removed to allow free action without this obstruction. If because of the flexed upper angle of the scapula the erect position of the shoulder cannot be maintained, an operation should be performed in which this flexed upper portion of the bone is removed, since as long as such a condition exists, the resulting forward position of the shoulder makes a recurrence of the bursal lesion a practical certainty.

At times as the result of the original inflammation in the bursæ the cavity has been so completely obliterated that in spite of all manipulation the adhesions re-form, and improvement becomes impossible from such methods. Under such circumstances an operation should be performed and the bursa removed. Both of these bursæ are easily reached, and following the complete removal of the bursal tissue normal function is often obtained, the absence of the bursa seemingly being of little importance.

If the symptoms are those of acute inflammation of the bursa, rest in a position in which there is no strain, heat by means of the application of the cautery, baking, hot-water bags, or similar measures, will usually be all that is required, and if no previous lesion has existed motion should be secured in a few days and adhesions should not form.

**Recurrent Dislocations.** If the chief trouble consists in an instability of the joint and there have been repeated dislocations, the erect position of the shoulder should be tried first, since in this position fifty to sixty degrees less rotation of the head of the humerus is possible, and this in itself may be enough to overcome the lack of stability. In one very obstinate case which the writers have seen, in which nothing short of an extensive operation seemed to promise relief, the effect of position was tried and after six months' use of a



brace to maintain this position no further trouble has occurred. Two years of free use of the arm has followed the giving-up of apparatus, while previous to the change of position of the shoulder the dislocation occurred frequently following very slight movements, such as raising the arm or putting on a coat.

In certain cases of injury, as Dr. Codman has shown, the tendon of the supra-spinatus muscle may be ruptured and instability of the joint be such as to make it advisable to suture this in place. If as the result of injury loose pieces of bone are present in the joint, as in one case which the writers have seen where a piece of the glenoid cavity had been knocked off and was free, these should be removed. At other times peculiarity in the shape of the coracoid process is such that it must exert a definite influence upon the production of dislocation, and under such circumstances enough of the tip of this process should be removed so that this source of difficulty will no longer exist. Whatever operation is performed or whatever other procedure is adopted, that position of the shoulder which brings the scapula flat against the back should be insisted upon. Anything short of this leaves the work only half done and the joint is left with less stability than should be secured. Unless this is recognized many operations will fail, and if it is recognized many operations will not be necessary.

**Brachial Neuralgia. Neuritis.** In case the symptoms are of pain in the arm or hand, the so-called brachial neuralgia or neuritis, resulting from the compression of the brachial plexus by the head of the humerus, the same correction of the position of the shoulder becomes necessary, and with the adhesive plaster strapping or braces this can usually be accomplished with entire relief of the symptoms. In one case which the writers have seen, however, the correction of the position in this way was not possible. The patient was a journalist, thirty-five years of age, who had always had sloping shoulders, and always stood with the body bent forward. For a year and a half previous to his being seen he had had intense pain in his arm whenever he attempted to write, so that dictation became necessary, but even with this whenever the body was inclined for-

ward more than usual for a short time the arm pain developed and was so intense that the patient's general health was becoming much impaired. At the time of the first examination the mechanical feature was recognized, and it was also recognized that the upper part of the scapula was flexed sharply forward, so that when the attempt was made to carry the shoulder back the tip of the scapula crowded into the ribs and caused pain at that point. To relieve this pressure the scapula was unconsciously rotated so that the long axis was directed farther to the outside than usual, at the same time lowering the glenoid cavity, and in this way the brachial plexus was compressed, so that in spite of all that could be done by simple means the mechanical conditions causing either compression of the brachial plexus or crowding of the tip of the scapula into the ribs persisted. After reasonable trial of non-operative measures unsuccessfully, an operation was performed, at which the flexed upper angle of the scapula was removed, and following this the shoulder could easily be carried erect, with an entire disappearance of pain and restoration of free motion. With the disappearance of the pain and the ability to use the arm in the normal position, and at the same time with the ability to stand erect, there was not only a return of full power in the arm, but marked improvement in the general health.

## CHAPTER XVII

### THE USE OF PLASTER OF PARIS IN ORTHOPÆDIC SURGERY

It would perhaps be harder for American and German orthopædic surgeons to dispense with plaster of Paris than with any other portion of their armamentarium. The English use it to a less degree, but its usefulness and adaptability seem to those who have become accustomed to its employment to be of utmost value.

Unless the surgeon becomes thoroughly familiar with the technique of its application, avails himself of the most perfect materials, and acquires a proficiency which only constant practice can supply, the method will ever seem cumbersome and the dressings will be unnecessarily irksome to his patients.

If one has a properly equipped machine shop and a cobbler's bench with skilled mechanics and leather workers always at hand, metal and leather apparatus may in many instances be fashioned which will as perfectly and perhaps with more nicety solve many of his mechanical problems.

For general use however plaster of Paris dressings will probably continue to offer the most simple and accurate method of affording protection and furnishing the immobilization demanded for the relief of symptoms and the correction of deformity.

It seems wise to the writers therefore to consider with some detail both the materials most adapted to its successful employment and certain practical points in its use which experience has emphasized.

Commercial plaster of Paris is made from a crystalline rock, gypsum, whose chemical composition is  $\text{CaSO}_4 + \text{H}_2\text{O}$ . This is ground to an impalpable powder and heated in an oven to a temperature of approximately  $180^\circ\text{C}$ . Upon the fineness of its grinding, the purity of the gypsum, the carefulness and thoroughness of its baking, and the secret details which different manufacturers guard,

depend the quality of the resulting plaster of Paris and its adaptability to orthopædic uses. Its consistency when ground should be that of fine wheat flour, and good plaster when mixed with one half of its volume of water at 72° Fahrenheit should set in six to ten minutes.

The best quality of plaster which can easily be obtained in America comes from Nova Scotia and compares favorably with the best foreign plaster. It is excellently suited to orthopædic uses and thoroughly satisfactory if one carefully selects certain grades and can be assured that it has not been unduly exposed to moisture. Setting, as it is called, occurs when this dry powder is mixed with water. It is a chemical process, and when uninfluenced by accelerators or retarders it is brought about by the supersaturation of plaster with water and the deposit of interlocking, interpenetrating rhombic crystals of  $\text{CaSO}_4 + \text{H}_2\text{O}$ . The microscopic interlocking of these interpenetrating rhombic crystals gives us macroscopically the firm and cohesive mass which we speak of as the plaster cast.

Heat and certain materials hasten the "setting," but also change the shape and cohesion of these crystals, and therefore as a rule make the cast more brittle. They are spoken of as accelerators. Other substances delay the "setting," and are used chiefly in the trades and arts on account of the greater length of time allowed for moulding. They are called retarders.

The chief accelerators are alum and potassium sulphate, both of which change the form of the crystals, the former into long fine needles and the latter into feathery masses. Sodium chloride, common salt, hastens the "set" when the amount used does not exceed 2-3% but in greater quantities delays the process, and its use is to be deprecated, since the resulting mass is more friable. Unless one is unfortunate enough to be obliged to work with damp plaster on an unsuitable bandage material it is entirely unnecessary. Glue, hair, sugar, sand, glycerine, starch, etc., retard the set. Glue and starch are the most important of these, from our point of view, since the material commonly used as the basis of plaster bandages ordinarily contains either one or the other and frequently in large enough

amounts to materially interfere with the speed of setting desirable in orthopædic work.

Plaster of Paris after it is set may be hardened and made nearly waterproof by dipping it into a strong solution of alum which is boiling. This is followed by a bath in boiling soap and after a coat of liquid paraffine the cast may be polished. If plaster be mixed with 10% marshmallow root and then after setting be dipped into the boiling alum solution an extremely hard mass results which may be hammered, sawed, or turned in a lathe.

Thanks to the general use of plaster of Paris by the dental profession and their demand for a very quick-setting form, it is possible in nearly every centre to obtain good plaster. The dental supply houses usually carry two grades, the quick-setting and the ordinary dental plaster. The quick-setting has mixed with it some of the accelerators, most commonly potassium sulphate, and is not well adapted for orthopædic use, both on account of its too quick set and the friability of the resulting cast. The medium grade is in the main satisfactory and can be purchased by the barrel. It keeps without difficulty in any dry place.

The writers have for many years used a so-called dental plaster supplied by a firm dealing in masons' materials. It is rather more economical than that furnished by the dental supply houses and in our experience quite as applicable to orthopædic uses. For the casts made without the use of cloth the still cheaper moulders' plaster answers every purpose.

### *PLASTER OF PARIS BANDAGES*

The proper rolling of a plaster bandage is an art in itself and it is of great importance to select a cloth which does not materially retard the setting, is elastic when wet, and makes a tough, firm dressing.

Crinoline has been proved by long experience to be well suited for the purpose and is in general use. Most of the crinoline on the market is stiffened with a glue sizing which interferes seriously with

the set of the plaster. If this glue-sized crinoline is to be used therefore it should be thoroughly washed and dried before being impregnated with plaster. Some makes of crinoline however are stiffened with starch, and if this is the only sizing used and the mesh is not too fine, the time required for setting is not materially lengthened and the resulting bandage is tougher, while the slimy smoothness imparted to the wet plaster aids in its accurate application.

The writers use a so-called dairy cloth, rather coarser than most of the finer grades of crinoline, which is stiffened only with starch and is less expensive than the finer grades of crinoline. Bandages made with this are easy to apply, set with all the quickness which can be desired, and the resulting cast is satisfactorily tough.

Both Meisenbach <sup>1</sup> and Stern <sup>2</sup> advocate the use of fine grades of Portland cement in combination with plaster. They state that when not over ten per cent of this cement is thoroughly and evenly mixed with the plaster the time of setting is not materially lengthened and the finished product is of much greater tensile strength and therefore more durable than that made with plaster alone.

The writers have used this to a limited extent and agree that dressings can thus be rendered more durable. They have found it difficult however to have the plaster and cement mixed with the complete thoroughness desirable, and with the type of cement used by them are inclined to believe that even five per cent materially lengthens the time of setting. Its usefulness in certain instances is unquestioned. The writers do not feel that its employment is strongly indicated "for everyday use."

Various machines of greater or less merit have been devised to diminish the labor of rolling plaster of Paris bandages. None of these machines turn out a finished product superior or in our opinion quite as good as the hand-rolled bandage. They do however save much time where large quantities are used.

Whatever method of rolling is employed the plaster should be worked into the meshes of the crinoline and spread in a very thin

<sup>1</sup> Stern, *American Journal of Orthopædic Surgery*, April, 1907, p. 356.

<sup>2</sup> Meisenbach, *American Journal of Orthopædic Surgery*, July, 1906, p. 1.

film over the surface. The rolling should not be tight, in order that when immersed the water may have easy access to all turns of the bandage.

The water should be lukewarm rather than hot and the bandages placed on their sides in the pail, and allowed to remain until air bubbles cease to rise. They are then seized by both ends and only partially wrung out so that the water does not drip, but so that the bandage is "squashy" and soft.

These bandages should never be applied over the bare skin, but always over stockinette or sheet wadding. All the bony prominences must be well padded, usually with saddler's or piano felting. If great pressure is to be employed there should be a corresponding increase in the padding. It will be found in these cases useful to apply a plain gauze bandage over the padding before the plaster bandages are used in order to obtain an even pressure throughout and to aid in the smooth application of the plaster.

Upon the thoroughness with which the plaster is rubbed in at each successive turn of bandage and upon the even thickness of the finished product will depend in large measure the strength of the dressing. If proper care is taken in observing these two points, and if all wrinkles are avoided, comparatively light dressings will be found to furnish more than sufficient strength to accomplish their objects. The comfort of the patient is thus greatly enhanced and the chief objections to the use of plaster of Paris dressings removed. Rarely for any purpose or at any point should the cast be over a quarter of an inch thick and usually a thickness of an eighth of an inch will serve every purpose.

Over large and sharp bony prominences such as kyphoses and over prominent tendons it may be wise to cut windows in order to avoid abrasions and painful sloughs.

The chest should be left as free as possible and in most cases requiring the use of plaster jackets it will be found of great advantage to the patient's general health if generous windows are cut over the front of the thorax and upper abdomen in order to permit free lung expansion. The windows are best cut after twenty-four or

forty-eight hours when the plaster has become thoroughly dry and the set is firm.

In applying a bandage to a limb for the immobilization of a joint the cast should extend as near as possible to the joints above and below. Only in this way can efficient immobilization be accomplished.

### *JACKETS*

Many methods have been devised for the application of plaster of Paris jackets, used largely in the treatment of tuberculosis of the spine. The head suspension of Sayre was the earliest practical method, is still largely used, and will always offer certain advantages over the other devices.

Of the recumbent methods the hammock made of stout cloth stretched between the two ends of a gas-pipe frame, the tightness of which can be regulated, is comfortable for the patient and easy for the operator. The patient lies face downward and the degree of hyperextension is dependent upon the slackness of the hammock. The writers have found it difficult by this method alone to gain close apposition of the bandage to the upper chest and sterno-clavicular region. Unless this close apposition can be accomplished the most powerful counter-point of pressure in the retention of the desired hyperextension is lost when the patient assumes the upright position or is rolled on the back.

For these reasons the frame devised by one of us (Figure 50) for the application of jackets in the recumbent position, but with the patient lying on the back, has proved most efficient and is commonly employed. Any desired degree of hyperextension by the use of the long steels or pressure over the kyphos by the use of the short steels can thus be gained. This hyperextension is fully retained in the upright position, since the important sterno-clavicular region is left entirely accessible for the close apposition of the bandage. This method is not applicable to cases of disease occurring above the fifth dorsal vertebra.



All jackets should be carefully moulded over the well-padded anterior superior spines and the iliac crests.

Calot has devised a technique which is ingenious, accurate, and with practice very rapid. Reference has been made to this in an earlier chapter.

In many of the conditions for which jackets are employed, especially in adults, the standing position, with the arms outstretched and the hands grasping supports on either side, is adequate. The method of application in the recumbent position with the body sagging between two tables, on one of which the pubes rests, while the other supports the upper chest, or supported by straps of webbing or greased leather stretched across a large Bradford frame, is applicable to those cases in which counter-pressure on the upper chest is not essential, but in which careful moulding with firm pressure over the low lumbar and the sacro-iliac region is necessary.

### SPICAS

Only one point seems important to emphasize in the application of plaster spica dressings, but upon this will depend in large measure both the successful accomplishment of the object for which a spica should be employed and the strength of the resulting dressing. The buttock of the side on which the spica is applied should be well covered in by the bandage and firm pressure exerted on these soft tissues posterior to the trochanter. Support at this point aids greatly in immobilizing the hip joint, adds strength to the dressing where it is always weakest, and thus avoids the necessity of the employment of such reinforcements as steel bands, rattan, etc., which are at best unsatisfactory.

The practical method of accomplishing this is to make the successive turns of the bandage, as they ascend the thigh and in a figure of eight encircle the pelvis, cross each other on the thigh in line with the trochanter, and not cross after the manner of the text-books, in front, in line with the apex of Scarpa's triangle. The "herring bone," so-called, made by the crosses of the bandage, will then be seen to ascend laterally instead of anteriorly.

*LEG PLASTERS*

It will be found useful to incorporate anchor straps in plasters applied to the lower limbs, but which do not include the foot. In limbs whose shape is at all conical it is difficult to keep such plaster dressings in place when the patient is allowed to assume the upright position, and their lower edges impinging on the malleoli often cause much discomfort. Anchor straps are made by applying a strip of adhesive plaster about two inches wide and twice the length of the limb to each side of the leg from the upper thigh to the malleoli. The stockinette and padding is then put on and the first layers of plaster bandage applied. The strips of adhesive plaster are then turned up, being covered in and held fast by the remaining layers of plaster of Paris bandage. The resulting dressing is thus kept from slipping down as long as the adhesive plaster remains adherent to the skin of the limb. The necessity of carrying the bandage well up to the thigh and well down to the malleoli may be again emphasized.

*FOOT PLASTERS*

Plaster of Paris bandages are often used to retain the feet in corrected positions, following manipulative or operative procedures. A precaution which the writers have found of great value is never to retain the foot in the corrected position while the plaster is hardening by seizing it with the whole hand and thus denting the plaster on the dorsum of the foot over the tendons. It is not difficult to retain the desired position by placing one hand on the knee to prevent its flexing, and with the palm of the other hand to exert pressure in the desired direction only upon the sole of the foot to be corrected. In this manner all danger of sloughs may be avoided. All foot plasters should be carried well down over the toes in order to avoid the danger of painful congestion. The end of the bandage should of course be left open and an opportunity afforded to inspect the toes and determine the condition of the circulation.

*REMOVAL OF PLASTER DRESSINGS*

In spite of the numerous instruments on the market devised to facilitate the removal of plaster of Paris dressings, the writers prefer a short stout knife with a slightly concave cutting edge to any device they have tried.

If a long notch or gutter is made in the cast and water applied with a medicine dropper allowed to run in this, the task of removing a plaster of any reasonable thickness is easy.



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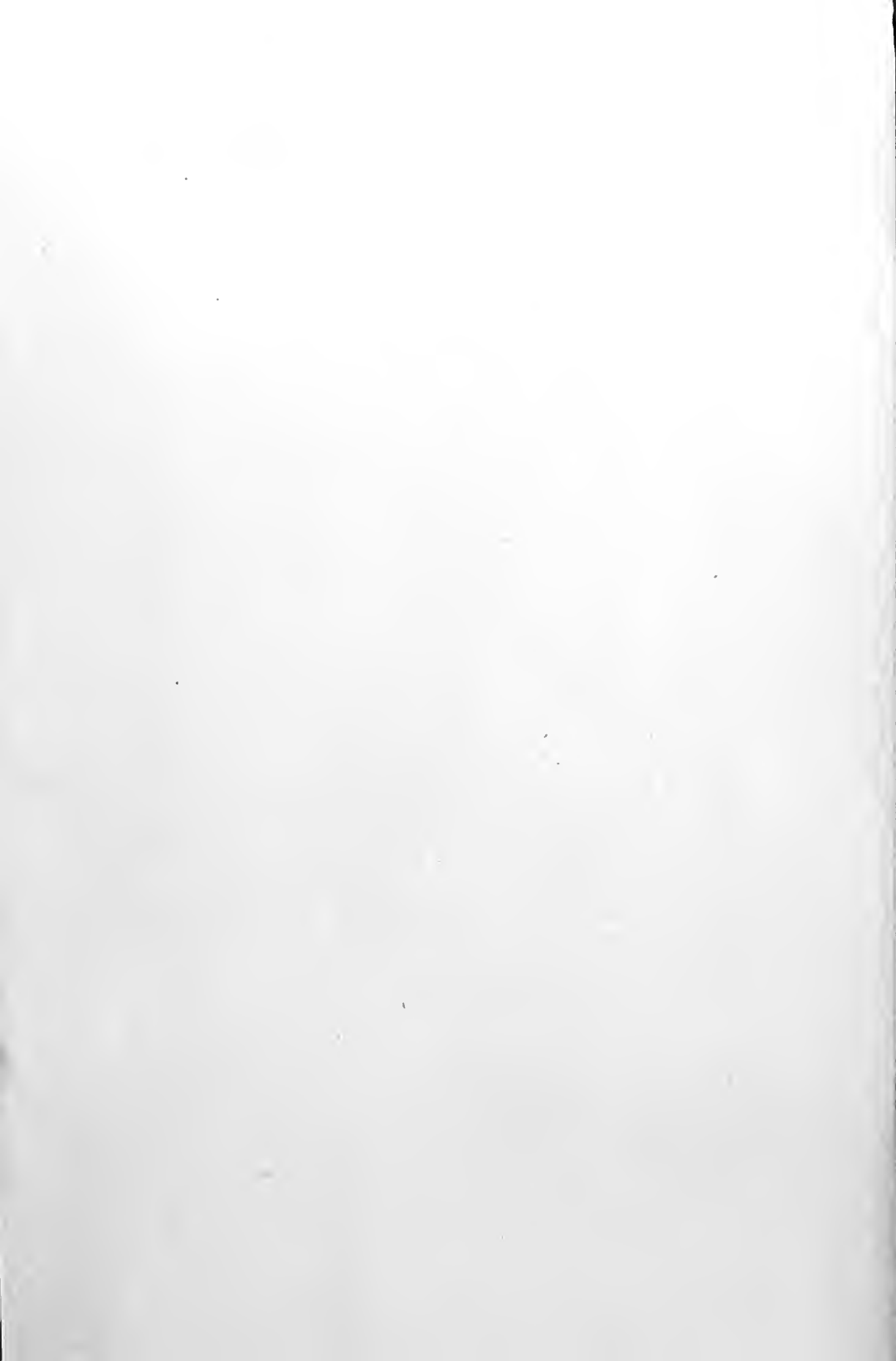
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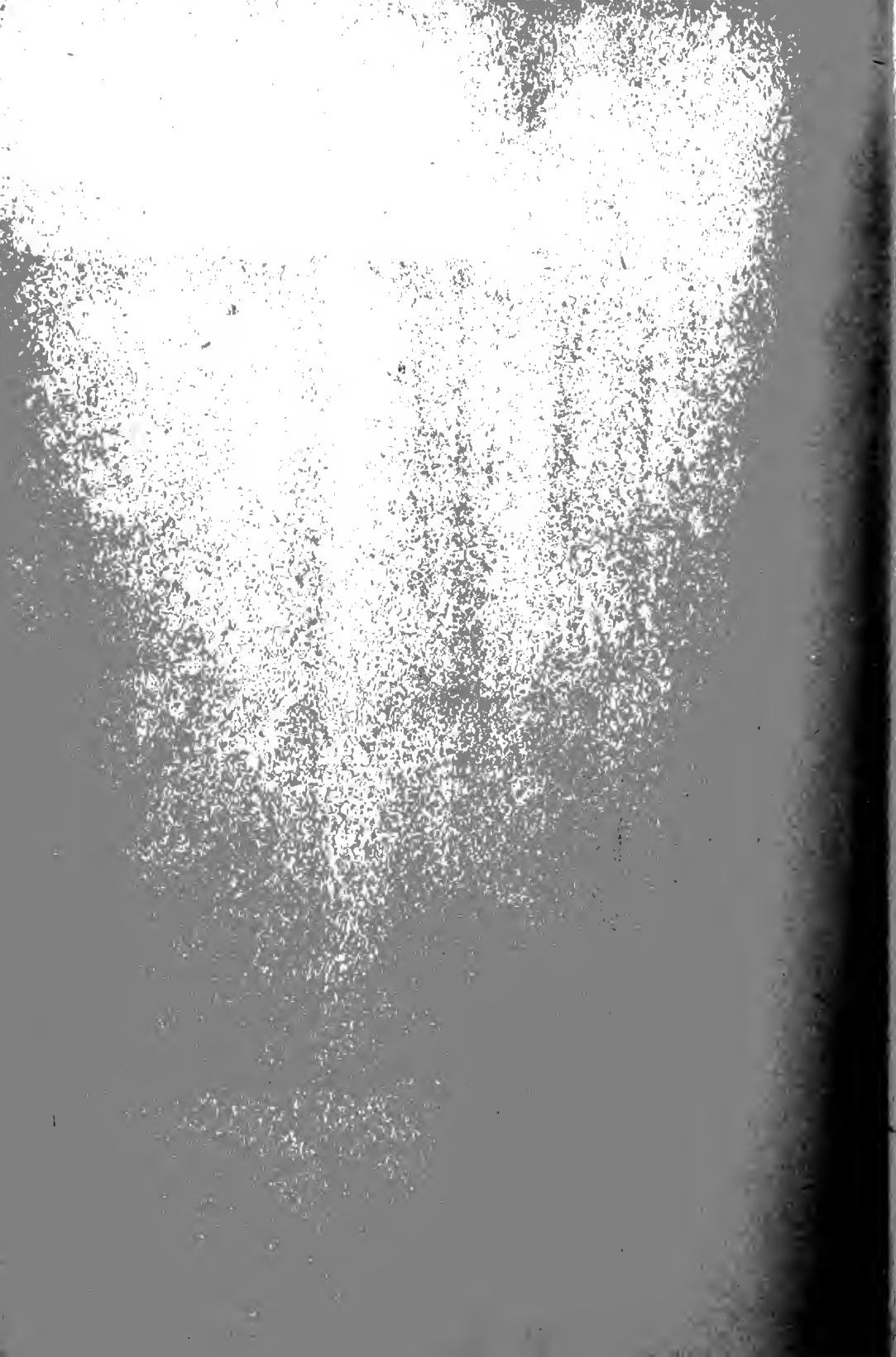












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